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MACHINERY:

VOL. I. No. 2. OCTOBER: 1894.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY.

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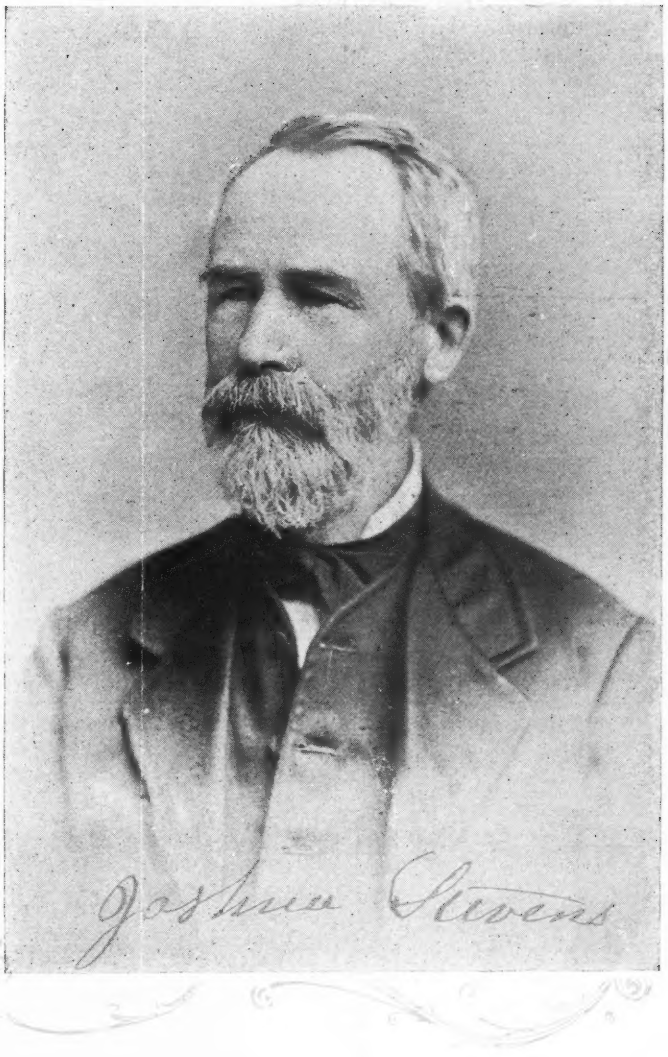

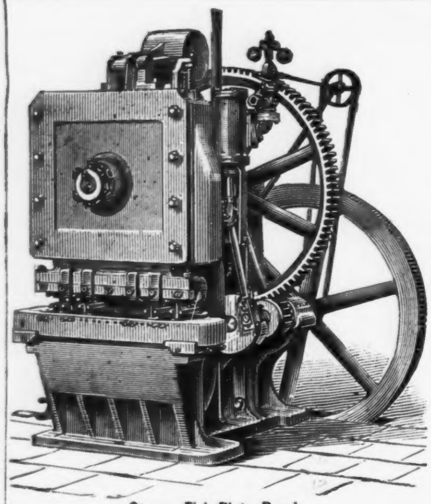

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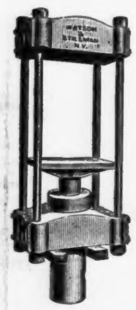

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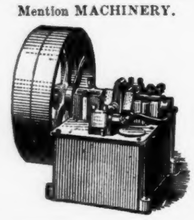

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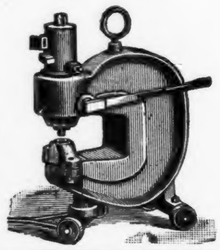

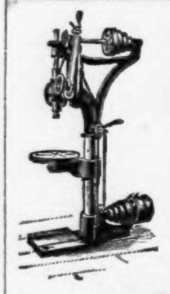

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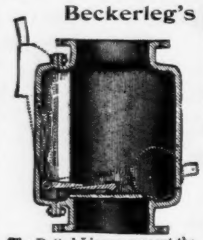

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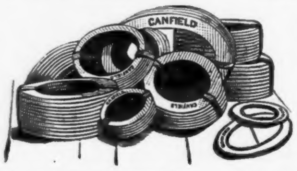

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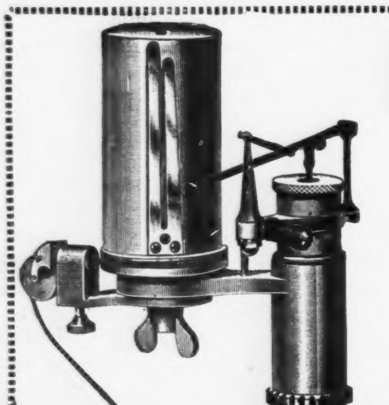

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MACHINERY.

VOL. I. October, 1894. NO. 2.

SIXTY YEARS A MECHANIC.

BEING SOME REMINISCENCES OF AN OLD WORKMAN.

JOSHUA STEVENS.

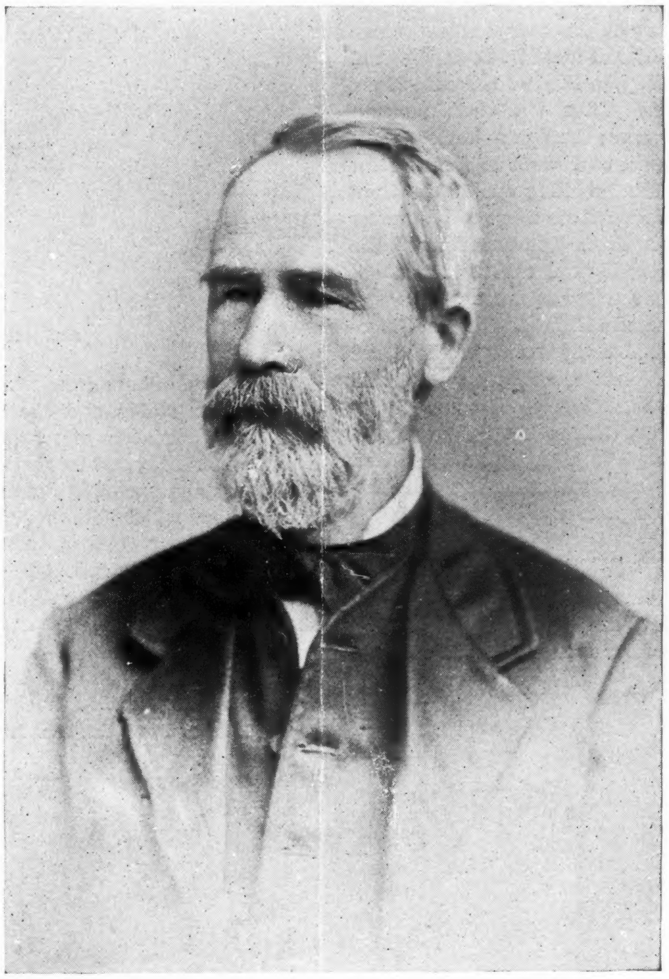
MACHINE SHOP practice is vastly different now-a-days from what it was in 1834, when I was an apprentice working in a small shop in Chester, Mass., where I served three years, the site of which is now a brush heap. Here I was paid $6.00 per month for the first year, and $8.00 and $10.00 respectively per month for the two succeeding years. I was considered a fairly good all-around mechanic and a handy man at almost any kind of shop work, but I was satisfied to get a dollar a day for my labor and I worked from 5 o'clock in the morning until 7, knocking off half an hour for breakfast, then to work again, with a respite at noon and working till 7 at night.

In the spring of 1838 I settled with my employer, taking his note for $150 00, and have the note yet.

Now men want three and four dollars a day for eight hours' work. It is true that some expenses were not so great as they are to-day. For instance, board was obtainable at from $1.50 to $2.50 a week; but, on the other hand, a good many things were much higher. From an old day-book, written in 1837, I have taken some entries, showing the prices then prevailing:

Flour, per bbl.......	$11.00
Rye, per bush.......	1 33
Corn, " "	1.50
Nails, per lb........	.07

The principal tools in the shop were a lathe and a milling machine, both crude affairs, with very little resemblance to the tools of to-day. Surfaces were first chipped and then filed smooth, a handy man with a file being able to smooth up quite a lot in a day. Drop forging was of course unknown, all that work being done by hand. A mechanic was expected to be handy at all the different kinds of work in the shop, and not limited to specialties, as at present, which gives him no chance to learn anything. I cannot help thinking that the prevailing practice is very bad for the rising generation, and it can not fail to produce a class of men—in fact, it *is* producing a class of men now, who are good for nothing outside of the limited routine of work that they are engaged on. When they lose their job they must find another at the same kind of work, which is more difficult than if they could go into a shop and take up anything.



Joshua Stevens

Most of my time has been spent on pistol and gun work, and I suppose I am as familiar with that class of work as anyone living in this country to day. In the small shop where I learned my trade they made cotton machinery, which doesn't much resemble the cotton machinery turned out by the Knowles Company, nor did the shop bear a very strong likeness to their works.

The modern pistol and rifle began to be evolved about 1838. In that year I went from Chester to Springfield, Mass., and commenced work for Cyrus B. Allen, who had a small gun and pistol shop in the latter place and who made muzzle-loading fire-arms, and what was known as Cochrane's revolver. We had a plane head machine, which we used for milling—am not sure but that it had a wooden frame, and we also put fixtures on a wooden bed lathe and milled barrels. Percussion caps at that time (1839) were not made in this country, but soon afterwards they were introduced and used on the Jenks gun, which was also made first by Mr. Allen This type of arm was followed by the Sharp rifle, the manufacture of which was continued in almost its original form until quite recently.

While I was in Springfield, the Boston & Albany Railroad, then known as the Western Railroad, was being built, and I well remember seeing what at that time was considered a gigantic steam shovel, at work cutting a ditch through the town. The building of this road was considered a stupendous undertaking in those days, and few believed that it would ever be extended to Albany.

In 1844 I went to work with Harvey Waters, at Stafford, Conn., and helped him to turn out the first pin machine made in this country. About the same time Dr. Howe, of Birmingham, Conn., went to England and devoted himself to the study of pin manufacturing in that country; returning here shortly afterwards he got up a machine and organized a company to manufacture pins, which is in existence to-day. The Waters machine turned out a pin with a spun head, and the Howe with a solid head; and as there was more or less competition between them, Howe's company bought Waters out, and took his machinery to Birmingham, Conn.

Soon after this I first met the celebrated Sam Colt. He first appeared here as a lecturer on astronomy, and in travelling around the country ran across a man with a crude idea of a revolver. Colt was an exceedingly bright man, but not very much of a mechanic, so he got a German to work this idea up, and finally obtained a patent on it. Then he organized a company to manufacture it at Paterson, N. J. They did not meet with much success, and had been in business but a short time when the company failed, but Colt was bright enough to rescue his patent from the wreck. With this as his sole possession he went to Eli Whitney's, at Whitneyville (New Haven), Conn., and got him to manufacture his revolvers for the Government. After a little, Colt thought he could save money by getting a shop of his own, and I remember riding over the Connecticut Valley with him as far as Middletown, looking for a location and picking up machinery. He started up a small shop on Pearl street, in Hartford, and here I made for him the first model of Colt's revolver that was made in Hartford. He interested a number of moneyed men in his enterprise, and the company prospered wonderfully, selling its arms all over the world, and from this small beginning was built up the present Colt's armory and fortune. In 1849 I patented a revolver of my own, and coming to Chicopee Falls interested a number of capitalists, who started the Massachusetts Arms Company. The work done on these revolvers was of the finest description, and, in fact, will compare favorably with anything that is done to-day; but we were bothered a good deal at starting by the lack of suitable tools, and were obliged to buy most of our machinery in England, as comparatively little progress had been made in this country in the manufacture of fine tools of that character. About this time I met Mr. D. B. Wesson, in his brother's (Edward Wesson's) shop, in Hartford, Conn., where I made the model for my revolver. Then I worked along at Chicopee Falls for eight or nine years; finally my health broke down and I concluded to try a change, so I went to farming for a year. This brought me up to the breaking out of the Civil War, and a number of my friends induced me to go to Worcester and take charge of a pistol shop. From this was formed the Joslyn Fire Arms Company, of Stonington, which turned out quite a large amount of material for the Government.

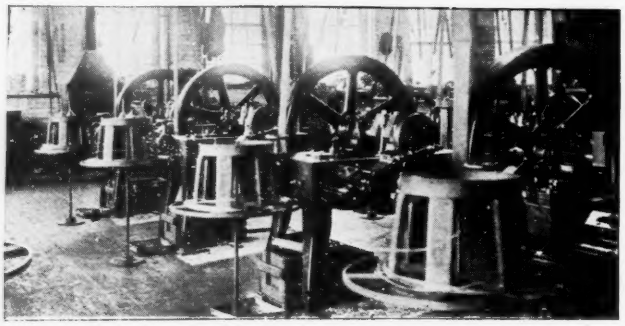
In company with two others I started a little shop here at Chicopee Falls, making a single-shot pistol of my own invention, and worked up on this line until we produced the Stevens pistol and rifle. In 1865 we commenced the manufacture of tools of precision, first producing a spring caliper, which was the first successful attempt to make such tools here. Two companies had started the manufacture of these tools before, but had failed, and I believe they were then made only in England and Germany.

* * *

A PAPER OF PINS.

FRED H. COLVIN.

The manufacture of pins was one of the first mechanical industries which engaged the attention of our forefathers, for as early

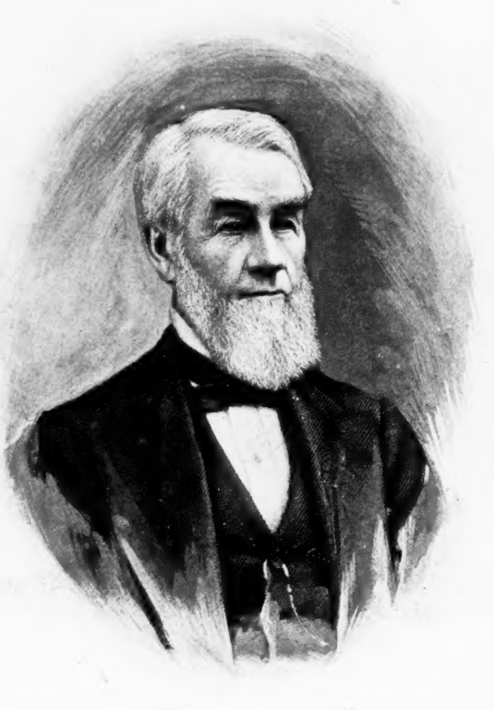


IN THE RIVET ROOM.

as 1775 the colony of Carolina offered prizes for native made pins, and a factory was started in 1812, but failed. Twelve years later Mr. Lemuel W. Wright, a native of Massachusetts, was granted a patent in England for a pin-making machine, but this, for some reason, was not introduced into the United States; and in 1842 Dr. John T. Howe, a New York physician in charge of a hospital, whose convalescents occupied their time by making pins by hand, determined to introduce into America the manufacture by machinery of these small articles. After a period of careful study, during which time he acquired knowledge of their manufacture, he returned to this country, bringing with him the necessary machinery for a factory, and founded what is now the Howe Mfg. Co, of Birmingham, Conn.

The machinery employed in the manufacture of pins, small and simple as they are, is probably more ingenious and interesting than that required to produce many larger articles, as illustrated by the accompanying engravings.

These, showing the manufacture of pins in various stages, were procured through the kindness of Messrs. Wallace & Sons, of Ansonia, probably the largest brass pin makers in America, who afforded every facility for obtaining the views, seconded by their superintendent, Mr. Joseph Naramore, and others.



DR. JOHN T. HOWE.

The ingots, or bars from which the pins are finally made, are cast in iron molds, and are about 1½ by 3 inches and 6 feet long, being a mixture of two parts copper to one part zinc. By continuous rolling and frequent annealing these bars are reduced to sheets about one-eighth of an inch thick, and then passed between rollers which slits them into small square strips ready for drawing. The process of drawing is well known, dies of different sizes being provided, and by continuous drawings and annealing the wire assumes the right diameter for pins, the illustration showing a pile of wire, just annealed and ready for final drawing.

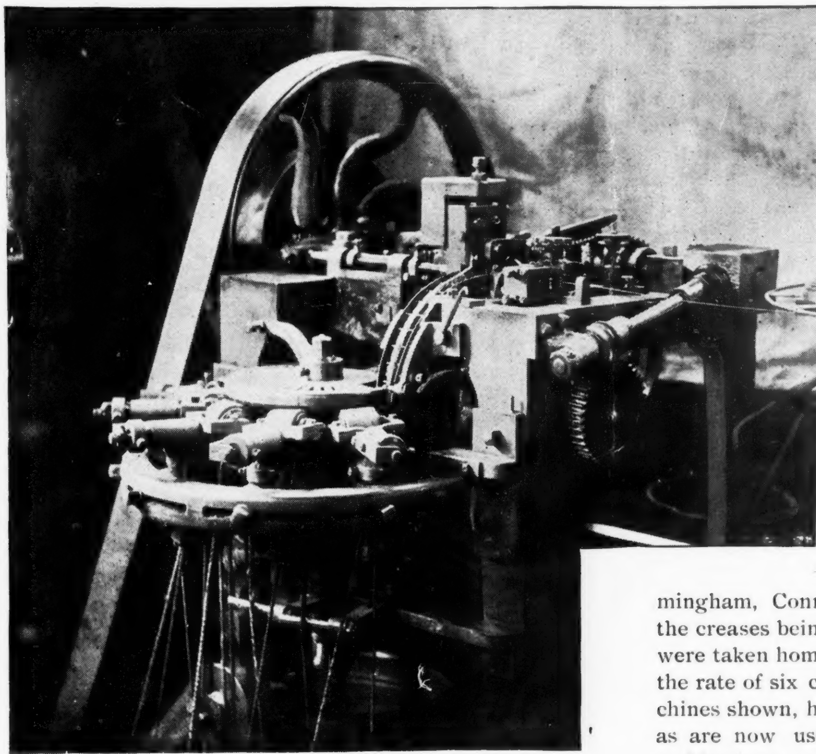
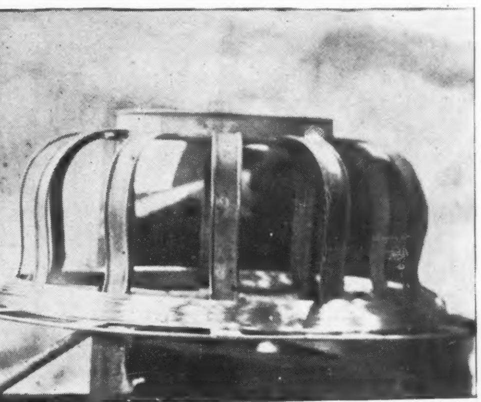
When it reaches the pin department proper the wire must first be straightened, as on the small reels it takes a permanent set, which is not allowable in the pin machines. From the small reels it is wound to the standard pin machine reel, 22 inches in

A ROW OF PIN MACHINES.

diameter, at the rate of over 1,000 feet per minute, passing through a combination of horizontal and vertical straightening rolls, which effectually take out the kink and leave it ready for the pin machine. The reel is now placed on the rack beside the pin machine, as shown at the right in the large view, and rollers draw the wire into the machine, where it is first cut off, then headed by three distinct blows, given by the cam and toggle at the left.

The headed blanks are carried down on the surface of the ver-

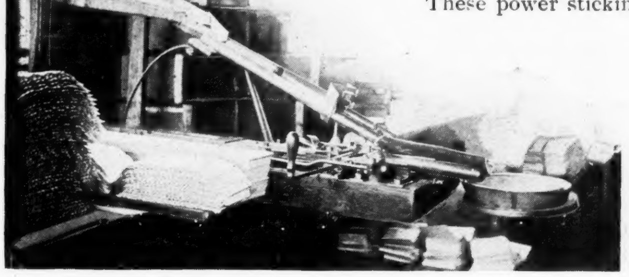
tical wheel, as shown, to the horizontal discs below. Here they pass between the two disks and are revolved by one running much faster than the other, at the same time being moved to the left over the revolving steel files, four in number, which make the points, finishing with an emery belt at the extreme left and hardly shown by the illustration. These machines are speeded

A PIN-MAKING MACHINE.

to make 160 pins per minute, and on the opposite page a view is shown of a portion of the fifty machines at work in this room. As these machines require practically no attention, they are run about fourteen hours a day, and the number of pins made, allowing for stoppages, will exceed 5,000,000 per diem, the aggregate weight being from 1,200 to 1,500 pounds, according to size; the different sizes varying in weight from 1,100 to 18,000 to the pound.

The pins then travel to the tinning-room, where they are tumbled with sawdust for ten minutes to remove all oil and dirt, boiled for four hours with pure Banca tin, in a prepared solution, and after a bath of strong soap-suds to give them a smooth surface, a final tumbling with sawdust makes them ready for the sticking-room. Once there, they are dumped into the hoppers of the sticking machines and thence pushed out by revolving fingers to an inclined bed with radial slots, or "runs," into which large numbers of the pins fall, some being caught by the head, others escaping through openings to a pan below to be replaced in the hopper at leisure. The pins feed down these slots and drop in the "cutting-off" plate as it is moved slightly across the row, and when full the movement of a lever drives the small hammers down, forcing them into the paper, which is crimped at the same time and held for the sticking. These power sticking

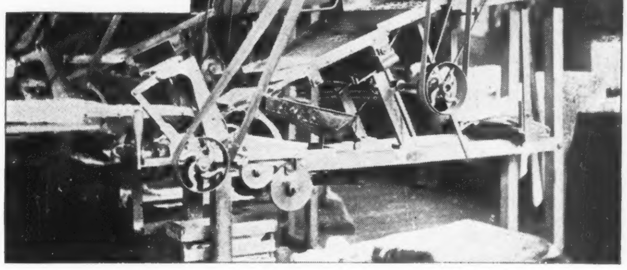



A HAND STICKING MACHINE.

machines were designed by Mr. Naramore in 1884, and have as many runs as there are pins in the row, the ones for cut sheets having 30 pins to the row and 12 rows to the paper being used in this machine, the attendant sticking about 2,400 sheets per hour.

Some of the sticking machines similar to the ones shown, are adapted for the cheaper pins, which are stuck into continuous rolls at the rate of 100 rows a minute and cut up into the required lengths after they leave the machine. These machines need very little attention, filling the hopper and renewing the rolls being all that is required. About the only feature of the business which has not changed is the style of putting up the pins, the old numbers of 14 rows of 20 each for cheaper pins and 12 rows of 30 each for the better grades still being used.

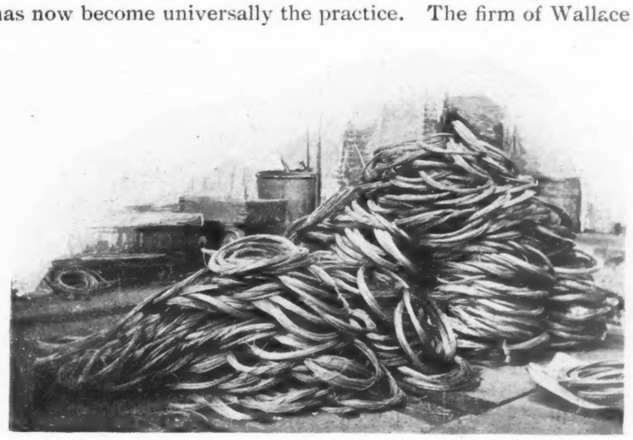
Fifty years ago, when Mr. Joseph Naramore was a boy in the pin factory at Birmingham, Conn., the pins were put into the paper by hand, the creases being rolled in by a machine, and the pins and paper were taken home by the farmers to do evenings, being paid at the rate of six cents per dozen papers. Next came the hand machines shown, having a single slot or "run," in place of 20 or 30, as are now used, and having a "cutting-off" plate and hammers much as in the latest ma-

A MODERN STICKING MACHINE.

chine, being operated by the levers shown at the side of the machine.

The first pins were made with wrapped or spun heads, the solid or "upset" head not being satisfactorily accomplished until it was discovered that two or more blows were necessary, and three has now become universally the practice. The firm of Wallace &



A PILE OF PIN WIRE.

Sons had its origin in 1848, and has grown so that the pin department is a small portion of the whole, the electrical industries having created an immense demand for copper wire in various forms, and this forms probably their largest department.

A FORMULA FOR THE SHOP.

A handy little formula for use in the shop a d drawing-room for finding the side of an inscribed square, having the diameter or circumference of the circle given is as follows. Let

S = side of inscribed square.
D = diameter of circle.
C = circumference of circle.

Then $S = D \times .707106$ and $S = C \times .225079$.

We want to know what size of square steel will just slip inside a tube 2 inches in diameter; so taking the first formula we have $S = 2 \times .707106 = 1.414212$, or a bar whose side measures 1.414+ inches is what we want. Or if we happen to know the circumference of a circle is 10 inches and we want to find the side of a square that will just fit inside, we take $S = 10 \times .225079$ inches as the size required. Now reverse the formulae and they are even more useful. What diameter must we turn a bar so as to make a square on the end of whose side is 1.4142+ inches, or what will be the diagonal of a square reamer whose side is 2 inches? Transposing the formula we have

$$D = \frac{S}{.707106} \text{ or } D = \frac{1.414212}{.707106} = 2 \text{ as before.}$$

Now what length of sheet metal will be required to make a cylinder which shall enclose a box 2 feet square, allowing 2 inches for the lap of sheets? Transposing the other formula we have

$$C = \frac{S}{.225079} \text{ and } C = \frac{24}{.225079} = 106.18 + 2$$

for lap = 108.18 inches, the length required, making two very simple and useful formulae for both shop and drawing-room.

* * *

THE DESIGN AND CONSTRUCTION OF MODERN STEAM ENGINES—I.

THEO. F. SCHEFFLER, JR.

General specification: A four-valve non-condensing horizontal stationary engine, *i. e.*, the live steam entering the cylinder shall be controlled by two separate slide-valves, connected by stretcher rods, so that each valve may be adjusted to the port; the two rotary exhaust valves to be driven by a separate eccentric.

Cylinder, 16x24 inches; revolutions, 170.

Piston speed, 680 feet per minute.

Diameter of steam pipe, 6 inches; of exhaust pipe, 7 inches.

Diameter of crank shaft, 9 inches; of crank-pin, 5 inches.

Diameter of crosshead pin, 3½ inches; of piston-rod 2⅝ inches.

Length of shaft from center of engine to end, 8 feet 6 inches.

Rated H. P. at 80 lbs. initial pressure (40 lbs. M. E. P. at ¼ cut-off), = 165.

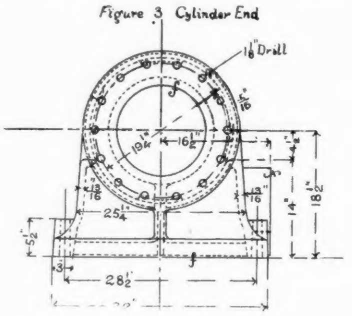
Max. cut-off ½ stroke = 250.2 H. P. (60.4 lbs. M. E. P.)

To be regulated by shaft governor.

It will be shown, as we advance, how each of these figures were calculated. Refering to the drawings, Fig. 1 is a plan view of the bed; Fig. 2 is a longitudinal side elevation of bed; Fig. 3 illustrates the cylinder end of bed; Fig. 4, a view looking at the shaft end of bed, and Fig. 5 is a cross-sectional elevation through centre of rocker-arm bracket boss on side of bed. The first thing to consider in designing a new engine is the style of frame, or bed; in this case it is a "Tangye" bed with bored guides. (See Fig. 5.) With this type of bed the metal is distributed very uniformly throughout the entire casting, without having any lumpy corners. Bored guides are prefered, being easily machined. The bed is tied together with ribs in the best possible manner, to receive sudden shocks that the reciprocating parts make at each end of the stroke, offset to a certain extent by the engine being thoroughly counter-balanced, and by a heavy fly-wheel to steady the velocity of reciprocating parts. In calculating the thickness of metal for beds, or, in fact, any part of the engine, always figure from the maximum horse power plus about 25 per cent., or instead of figuring from 165 H. P. we take the maximum horse power, which is at ½ cut-off, 250.2 H. P. plus 25 per cent., or 312.7 H. P.

By following this rule in designing the different parts we shall obtain the best results, and be on the safe side. Hereafter, in mentioning the maximum power of the engine, we shall call it 312.7 H. P. Another point to be considered in designing a bed, or cylinder, or in fact any part of the engine, is the moulding, and to do away with as many cores as possible, for this all counts in the cost. The machine work should also be carefully considered, to lessen the cost of the engine, but not in any way that would be detrimental. To calculate the distance from the bottom of bed to center of engine, we must first design our crank-disc, so that its outside diameter may be determined. The length of crank is 12 inches, half the diameter of crank-pin 2½ inches; we require about 2½ inches around the crank-pin, and adding together gives 17 inches from center of shaft to outside of disc, and multiplying by 2 gives 34 inches diameter for crank disc. Allowing ¾ inch clearance between disc and bed, also ¾ inch for metal under disc, and adding to 17 inches gives 18½ inches from center of engine to bottom of bed. For proportioning the length of bed, we must first settle on the length of connecting-rod. Three times the engine's stroke is considered very good practice; 2½ and even 2¼ times is common in small engines, but as three times works much more smoothly, we will settle on this, making the connecting-rod 72 inches long, center to center. We must calculate the length of bed with crosshead at the cylinder end. The distance from center of crosshead-pin to face of hub on crosshead is 10¾ inches; thickness of piston-rod jam is 2 inches; allowing 4½ inches clearance between piston rod jam-nut and end of stuffing-box studs, also 4¾ inches more to face of bed, gives 72+12 (one-half of stroke)+10¾+2+4½+4¾=106 inches over all, which is the distance from center of shaft to face of bed where cylinder is bolted on. The distance from center of shaft to end of bed on shaft end, should be 30 inches, or about 1¼ times the stroke. The width of bed on the cylinder end should be proportioned from the outside diameter of cylinder flange The counter-bore being ⅛ inch larger than bore of cylinder gives 16⅛ inches diameter for this. Allowing 1 inch for grinding surface all around, using 1 inch cylinder-head studs, with $\frac{1}{16}$ inch between grinding surface and stud, we have $16\frac{1}{8}+2+\frac{1}{16}+1=19\frac{1}{4}$ inches to centers of cylinder studs. Allowing $1\frac{1}{16}$ inch outside of studs to give the necessary strength to flange, gives: $19\frac{1}{4}+2\frac{1}{8}+1$ (the other half of studs doubled up)$=22\frac{3}{8}$ inches for outside of cylinder flange diameter, plus $\frac{5}{16}$ inch for thickness of jacket, we have $\frac{5}{16}+\frac{5}{16}+22\frac{3}{8}=23$ inches over all for main body of bed where cylinder bolts on. (See Fig. 1.) The width of bed at bottom is found by allowing 4½ inches on each side of the main body, and adding we have 23+4½+4½=32 inches over all. It is necessary to have 4½ inches on account of draft for moulding, and for anchor bolts.

Figure 3 Cylinder End

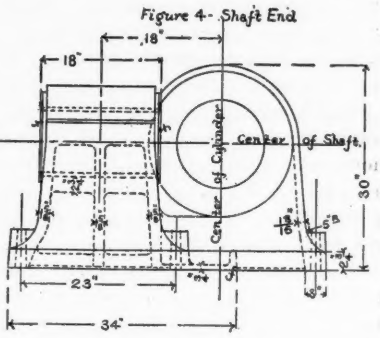


The crank end of bed is proportioned by the width of main journal, which in this case is 18 inches plus 4½ inches on each side of journal for flange at bottom, or 4½+4½+18=27 inches, the ordinary width of bed on shaft end, but as it is better to stiffen the crank end of bed at the bottom or side strain, we add 7 inches, which will carry a rib under the crank-disc, and perform two duties: that of stiffening the bed and acting as an oil reservoir to catch all drip from the main journal. Adding 7 inches to 27 inches gives 34 inches for the total width of bed on crank end. We have now the general appearance and outline of the bed on the outside; it is now necessary to look at the inside. Starting on the crank end, it is essential that a rib be located under the main journal to carry part of the load and to brace the side walls. This should be at least 1½ inches thick on this size engine; there is no

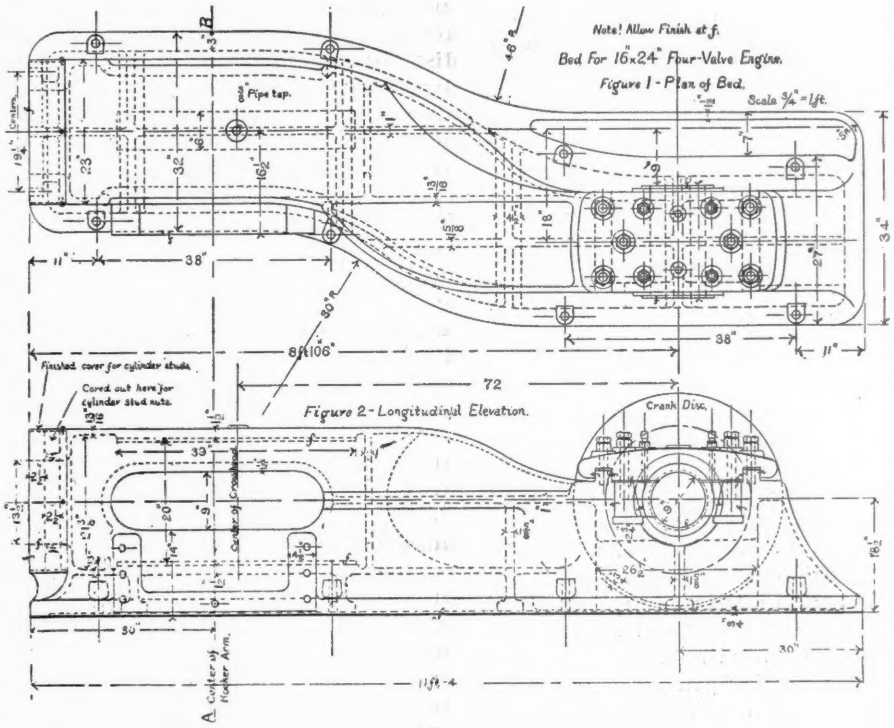
Those interested in the design and construction of modern steam engines will find these articles thoroughly practical (rather than theoretical), in plain, concise language and as free from mathematics as possible, making them especially valuable to shopmen and engineers.

fixed rule for the size of the ribs in the bed, they are generally made double the thickness of side walls, unless for a very large engine, when the proportionate thickness of ribs to bed-walls requires a little more metal. We should also place a rib under each end of crosshead guides to carry the thrust of connecting-rod when the engine is running over, due to the angularity of the connecting-rod; these ribs also strengthen the side walls and keep them from spreading. These ribs should be 1½ inches thick. There should also be a rib running longitudinally through the center of the bed, to act as a backbone, 1 inch thick will be heavy enough. The thickness of side walls of bed must be determined by the total initial steam pressure on the piston at each end of the stroke.

Figure 4 - Shaft End.



The total pressure based on 125 pounds initial pressure is 25,125 pounds; the bed must resist this at each end of the stroke. The tensile breaking load of good American cast iron is about 16,000 pounds per square inch of section. There should be a factor of safety of 8 in the bed; therefore dividing 16,000 by 8 gives us 2,000 pounds allowable for each square inch on side walls of bed. By referring to drawing, Fig. 2, we find the side walls are 14 inches high after deducting the 4½ inches from center of engine to bottom of opening in the side of bed.

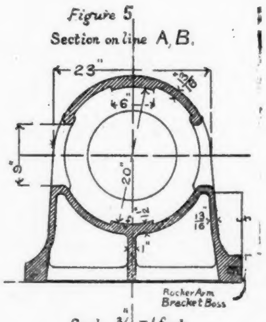


Bed For 16x24" Four-Valve Engine.
Figure 1 - Plan of Bed. Scale ¾" = 1 ft.

Figure 2 - Longitudinal Elevation.

We also find that by dividing the total pressure upon the piston, 25,125 by 2,000 pounds, gives us 12.56 square inches, required on both side walls of bed at the weakest point. Dividing 6.28 square inches (the number required on each side) by 14 inches gives us .448 inches in thickness for each side wall, or about $\frac{7}{16}$ inch thick. We must make allowance for the the metal not being of uniform thickness on both sides, and also make the bed strong enough to resist any sudden pressure on the piston, which would act as a blow on the bed, and probably break it at the weak point. It is good practice to add about .75 per cent. to the thickness found: therefore, $.448 \times .75 = .336 + .448 = .784$ inches, or about $\frac{13}{16}$ inch thick, giving a bed that will resist any pressure that would ever be put on the piston. The general thickness of bed can now be made $\frac{13}{16}$ inch thick all over, with a few exceptions. The side of bed directly under shaft should be just double, or 1⅝ inches thick. The thickness for slides should be about 1½ inches, to allow for reboring on account of wear. The thickness of metal around shaft should be about 2¼ inches, and the flange where cylinder is bolted on should be 2½ inches thick. The flange at bottom of bed should be about 3 inches wide. This size engine should have eight 1¼ inch anchor bolts distributed at equal distances on each side of bed. The main journal and cylinder will be illustrated in detail in the next article.

Figure 5
Section on line A, B.



Scale ¾" = 1 foot.

A BUFFING ROOM.

There are many shops where the intelligent adoption of a buffing department would work wonders in saving time and labor on much finished work. Even if you have not work enough to employ a buffer steadily, it will pay to have the proper appliances and get a man who can turn his hand to other work in the spare moments, although it would be saving money over present management to give him half or even full pay when not employed. In finishing brass, iron or steel castings, or forged work, the saving effected by good buffing-wheels and straps, handled by an experienced man, seems incredible to those who are accustomed to using the file, scraper and emery-cloth block or stick, and the uniformity and quality of the work will be much improved.

The quality of wheels and straps, emery or other abrasive supplied will affect the saving largely, for it does not pay to use poor materials. Solid wheels, wooden wheels with leather faces or rims, hide wheels and felt wheels are all good for certain work if of good quality, and the same may be said of rag wheels and polishing materials. The wheels should be well balanced, especially the larger sizes, and should run about 5,000 feet per minute, rim speed. This demands strong wheels, and they should be carefully looked after to avoid bursting and injuring the workmen. In renewing the emery on the rim the old and worn material should be thoroughly removed by covering with damp clay; this will loosen the glue, and it can be easily scraped off after the glue becomes softened. This is far preferable to the "picking" or "chopping" method employed by some, as this injures the face of the wheel and is apt to make it run "out of true."

* * *

It is false economy to give the men in the shop little or no washing facilities, as the cost is trifling compared with the sanitary effect and the good will of the men who naturally object to washing in second or third hand water and going home dirty. In one shop, to the writer's knowledge, where the men had to huddle around a big tub and take turns, the last man getting dirty water and suds, the men soon began going home dirty, and the name of "Blank's bummers" was quickly attached to all employees; and, though better washing facilities are now provided, the name still clings

* * *

PECULIAR LOCOMOTIVES.

The Baldwin Locomotive Works have just turned out three locomotives for the Erie & Wyoming Valley Railroad, which have some peculiar features. They are moguls, with 56-inch drivers, wide fire-box (not Wooten), and weigh about 120,000 pounds. The peculiar features are the *three* 17 by 24 inch cylinders, set on an incline, so as to allow the middle one to drive the main axle just inside the right driver, all being connected at 120°, so as to have a continuous pull, deemed necessary by the Master Mechanic, Mr. John B. Smith, of Dunmore, Penn., on account of the heavy grades on the road. The tank is also peculiar to American roads, and is the same as that adopted by Daniel Coxe Jr., of the D. S. & S. R. R., being a six-wheel tank similar to English practice.

* * *

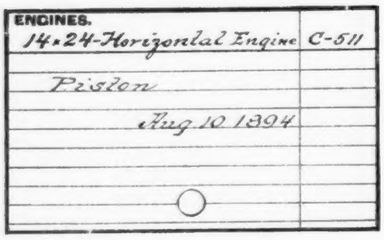
Brass work does not usually hold well on a taper steel arbor, but a thin film of chalk or three light chalk-marks about evenly spaced will help materially, and not affect the truth of the work to any appreciable extent.

DRAUGHTING-ROOM PRACTICE.

Walter B. Snow.

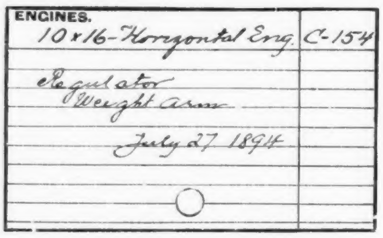
Just what relation the draughting-room shall bear to the other departments of the manufacturing establishment must depend largely upon the character of the business and the methods under which it is conducted. Wherever the articles manufactured are from new and original designs the draughting-room assumes its position of greatest importance. The mechanical progress of the establishment becomes absolutely dependent upon it, and work to be correctly done must be carried out fully in accordance with the lines laid down by the department acting distinctly as the originating head.

In many cases, however, this draughting department becomes merely secondary, the force is small, and the work consists mainly in recording changes made, or ideas evolved, by others. But whatever its relative position, however small the force, or insignificant the work, the draughting-room, nevertheless requires a head—some one individual directly responsible for all that emanates from it, and its, or his, position should be clearly defined. The draughtsman must not be at the mere beck and call of every foreman in the shop, and either the chief draughtsman or a superintendent in authority should dictate definitely and decisively in all matters pertaining to design or changes therein.



A working drawing generally serves two distinct purposes. First, as a representation of the object to be made, it informs the workman as to the desired dimensions, the material and the finish; while secondly, it is of no less importance as a permanent record of the piece or machine as completed. This second use is too frequently overlooked, until its importance is suddenly and vividly revealed in the endeavor to supply duplicate parts for repairs years after the machine was made. Then the necessity for absolute accuracy and the demand for perfect agreement between drawing and product is made clear. It must be apparent, then, that no drawing is too simple, no draughting-room of too little importance not to demand a careful consideration of the system to be employed in the making of the one or the control of the other. Certain general principles should rule in all methods adopted which look toward the most perfect results, and here, above all, the importance of the draughting-room as a factor in business should be recognized. While nothing particularly new may be here presented, it is, nevertheless, the desire of the writer to cover at least one or two points of importance and illustrate their practical application.

First of all a moment's thought must convince even the casual observer that the standard ratio of sizes of drawings as turned out by any given draughting-room must be of the utmost importance, and yet we find establishments without number where the sheet is trimmed to suit the size of the drawing upon it. The result is evident: an endless variety in sizes, the practical impossibility of properly filing the same in drawers, and the almost unlimited inconvenience in finding the smaller drawings when slipped in among those of greater dimensions in a large drawer.



Of course the standard sizes to be adopted must depend largely upon the character and size of the objects to be drawn, but for ordinary machine work there is scarcely a shop in which an 18 by 24 inch sheet will not serve for any and all drawings. If necessity absolutely demands, sheets based on the multiples of these dimensions, such as 9 by 12, 12 by 18 and 24 by 36 inches, can be readily adopted, each size forming two of the next smaller into which it may be easily sub-divided. The 18 by 24 inch sheet obviously cuts without waste, two sheets wide, from 36 inch stock. The convenience of using drawing paper, tracing cloth and blue print paper of the single width, of meeting all requirements of size therewith and of having no waste, must be experienced to be appreciated.

Just what method of designating and filing these drawings shall be adopted becomes, however, the draughtsman's most serious question, to be decided only after careful study and a thorough comprehension of the problem before him. The question as usually presented is, shall the drawings be classified under the machine they represent, or simply be numbered in the order of their completion. The first plan has in its favor the benefit of doing away with any complicated system of indexing and of bringing together, ready for instant inspection, all the drawings which relate to each other, as they serve to represent the parts of a single machine. But it is evident that such a method can be applied only where the machines are distinct from each other in design, having no parts in common; otherwise there is required a duplication of certain drawings in order that one may be filed with each of the sets covering the various machines for which it is used; then, too, changes in design calling for new drawings of part of the set tend seriously to complicate matters.

It would seem, therefore, that except under nearly ideal conditions, it is best to arrange the drawings independently of their exact relation to each other and then rely upon an index, with

10 × 16-HORIZONTAL THROTTLING ENGINE.

B. F. STURTEVANT CO., Jamaica Plain, Mass. SECTION A OF Nov. 27 1893. PRODUCTION LIST T 369. Continued on B.

ERECTION DRAWING 6-414. NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.	NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.
BED (Throttling)	6-139	Pat. 376	1	Cast Iron	CROSS-HEAD (Cont'd.)	G-42		1	
BED (Steam Fan.)					Key	"		1	Steel
					Pin (Wrist)	"		1	"
					Pin Nut	"		1	Wr't Iron
CONNECTING ROD.	G-34		1		Nut (Piston Rod)				
Body	"	Pat. x433	1	Steel					
Crank Box, Outside Half	"	Pat. 0763	1	Brass					
Crank Box, Inside Half	"	Pat. 0764	1	"					
Strap	"			Steel	CYLINDER.	G-411		1	
Key	"			"	Body	"	Pat. 7051	1	Cast Iron
Bolts	"	3/4"x6 3/8" Hex	2	"	Lagging	"	Pat. 7095 1716	2 2	" "
Nuts Case hardened	"	3/4"— Hex	2	Wr't Iron	Machine Screws Flat Hd	"	" 14-20x1/2"	28	Wr't Iron
Set Screws	"	5/8"x1 1/8" -	1	Steel	Studs, Front End	"	7/8"x4 1/2"-1 1/8"-1 1/2"	8	Steel
Wrist Box, Outside Half	"	Pat. 0774	1	Brass	Studs, Back End	"	7/8"x3"-1 1/8"-1 1/2"	8	"
Wrist Box, Inside Half	"	Pat. 0773	1	"	Nuts	"	7/8"-Hex	16	Wr't Iron
Strap	"		1	Steel	Steam Chest Studs	"	3/4"x3 5/8"-7/8"-1"	16	Steel
Key	"		1	"	Steam Chest Nuts	"	3/4"-Hex	16	Wr't Iron
Bolt	"	3/4"x5 5/8"-Hex	1	"	Head, Front End	G-417	Pat. 556	1	Cast Iron
Nut Case hardened	"	3/4"— Hex	1	Wr't Iron	Bushing	"	Pat. 06320	1	Brass
Set Screw	"	5/8"x1 1/8"	1	Steel	Gland	"	Pat. 529	1	Cast Iron
Babbitt					Gland Bushing	"	Pat. 01150	1	Brass
					Studs	"	5/8"x5 1/2"-1-4	2	Steel
					Nuts	"	5/8"-Hex	4	Wr't Iron
					Head, Back End	"	Pat. 577	1	Cast Iron
					Eye Bolts				
CRANK.	6-19		1		Plugs				
Pin	6-272		1	Steel					
Plate	6-19	Pat. 739	1	Cast Iron					
Shaft									
Key	6-19	7/8"x13/16"x3 3/4"	1	Steel					
					DRIP ARRANGEMENT.				
CROSS-HEAD.	G-45		1		Elbows				
Body	"	Pat. 161	1	Cast Iron	Unions				
Oilers	"	Pat. 164	2		Tee				
Cap Screws	"	3/4"x5 1/2" Hex	4	Steel	Valves				
Studs					Piping				
Nuts									
Bushings			2	Brass					

such other accessories as may be necessary to designate the number and filing location of all drawings required in the production of any given machine. Elaborate systems of book indexing have been developed and experimented with, but they all lack the one essential feature of expansiveness to suit all contingent conditions.

Nothing, in fact, has been found to meet the requisite feature of a good index system but the card catalogue or index. Made up as it is of individual cards, there is, perforce, between every two cards space for others, and consequently there is always a place, not approximately, but exactly right for each new card that may be written. It makes no difference whether the subject matter indexed be drawings, patterns, tools, or even addresses, forces, costs and the like, the card index is always elastic, equal to any emergency and capable of use even by those having the most limited knowledge regarding it. It obviously makes no difference what may be the method of numbering and filing the drawings, they can always be found, if in their places in properly designated drawers.

The simplest method of dealing with drawings made upon a series of standard sized sheets is to designate each by a distinctive letter, a number which, representing the consecutive position of

this drawing among others of its size, in the drawer may then follow the designating letter. Thus, C76, C77, etc., will follow along in order as they are completed, and be filed thus in the drawer prepared for them, which would be labelled, for instance, C51 to C100.

If for certain purposes of convenience, due to a wide diversity in the subjects represented on the drawings, it is desirable to separate them into general classes as, for instance, steam engines, boilers, heating apparatus and the like, this separation may be easily accomplished by prefixing to the letter a designating number. Thus, 1C might cover engines only, 2C boilers, and 3C heating apparatus, as drawn upon sheets of the C size; the suffix numbers in each case running from 1 upward in consecutive order, and the drawings being filed in entirely distinct sets of drawers.

The principles to be followed in making up the card index are that for each drawing there shall be at least one card, clearly specifying the title, the date and the number. When more than one object is represented upon a drawing, a card should be made out for each, except under certain established conditions. Obviously, an assembly or erection drawing would not be itemized on the cards as to its individual parts, while it might be a question whether a complete connecting rod drawing should be treated in the same manner. The decision must rest largely upon the use that is made of this particular index.

Most important in any index is the system of cross references, whereby the inquirer is led from his supposed to the proper title. He may question whether to look for the bed, the base, the foundations or the support of an engine, but in a complete index he will find under each of these words a reference to the one adopted to indicate the object he has in mind.

The standard size index card is 3 by 5 inches, and may be obtained ruled in any manner required for the proper division or separation of the inscriptions to be made upon it.

The simplest divided card is of the form illustrated in Fig. 1, which, in addition to the regular horizontal lines, has only a single vertical line at the right serving to separate the drawing number from the rest. This sample card well indicates the relative arrangement of the inscriptions.

As will be noted, the primary division under which the card will be filed is indicated by the printed heading "Engines." Such printed head lines are of great convenience and lend uniformity to the index as a whole. Next important is the size of the engine, then the part thereof. In this case there is a division within a division, the regulator forming an individual feature of the engine and comprised of various details. The drawing number to the right and the date below complete their record of the drawing, which is thus rendered distinctly different from, and not to be confounded with, any other.

By proper filing all cards relating to this individual engine are brought together in their alphabetical order, and it may at once be seen how many and what drawings have been made for any given detail. Incidentally the patterns, being designated by their numbers upon the drawings, are likewise indexed by title and easily found.

As such an index grows, the difficulty arises of being able to decide which of a number of drawings by the same title is the one at present in use. Notes upon the cards, or even the drawings themselves, are doubtful evidence. They are apt to become lengthy, and are more than likely to be overlooked. Some means must be adopted to indicate clearly and without question the drawings necessary in the manufacture of any given machine. This information naturally takes the form of a list of the drawings, to which may well be added, as illustrated in Fig. 2, the pattern and piece numbers, the number of pieces required for a complete machine and the material of which they are to be made. In this particular case the schedule, of which only a single sheet is shown, has been suggestively entitled a "Production list," and serves, in the form of blue prints made from the thin paper originals, as a complete specification for each machine, leaving no opportunity for excuse on the part of foremen or workmen because of lack of information. Changes in design naturally result in changes of these lists, which are thereafter designated by new distinguishing numbers. As a matter of record blue prints are retained of the list as it appeared and with the number identifying it before the changes.

It must be evident that such a system of production lists, properly incorporated in a system of machine records, forms the most complete evidence of the exact construction of each and every machine. Its value in the matter of supplying parts for repairs is almost inestimable, and it serves in every way to promote accuracy in both draughtsman and workman.

* * *

AN ELLIPTIC CHUCK.

J. B. Rich.

One of the greatest inventions, to my mind, as an apprentice, was the elliptic chuck, which I had heard of but never seen, and which a rival shop was known to possess and guard with jealous care. I designed several arrangements which I thought might work, but never had a chance to make one, and when I ran across the one shown below I got permission to photograph it, so as to show the younger mechanics how easily an elliptic chuck can be made, for this is the simplest one I have seen. Such things are less secret than they used to be, and Mr. Caldwell, of Smith & Caldwell, Philadelphia, gave me liberty to get any details I desired. The cut is drawn to scale, and any size chuck can be made from it.

The chuck consists of two main parts, each composed of several minor pieces. The slide A is threaded for the lathe spindle and is free to move vertically across the face-plate C, or properly speaking, to allow the face-plate to move upon it, as it is fixed to the lathe-spindle. The plate B is free to move at right angles to A, and is held to plate C by the strips D D, secured by screws as shown. In the other part we have the body or plate F, which is fastened against the face of head-stock through bolt-holes shown, the spindle projecting through the oval opening in the adjustable

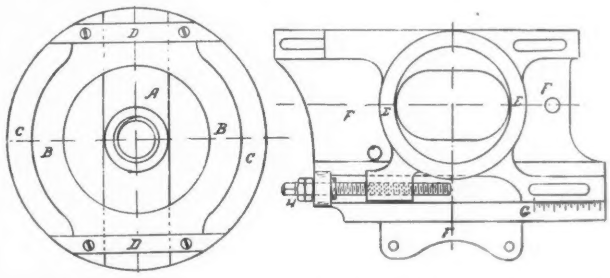


plate E E. The ring E fits the plate B, which turns on it, and the position of the ring E determines the eccentricity of the ellipse, In the position shown the ring is central with the spindle, and the face-plate C will revolve in a true circle. The graduations at G show the eccentricity in inches and fractions of inches. The frame carrying the ring E E moves on the plate F in gibbed ways, held by bolts in any desired position.

Moving the frame and ring E to any desired position by screw H, we move the plate B from its central position and force it to revolve around a centre which is not central with the lathe-spindle on which the slide A revolves. Turning the lathe-spindle we move A, the face-plate C, which slides on B so as to accommodate the new center of revolution for B, and in so doing also slides on A, giving it an elliptical motion depending on the distance the frame E is moved from its central position on F. The graduations make the setting a very easy matter. The exact motion cannot be followed on paper without going into details, but any one interested can construct a model out of stiff cardboard and follow its movement very clearly.

For die work and similar places where elliptical shapes are used daily, it is invaluable, and its ease of adjustment and simplicity, combined with the strong construction, makes this particular chuck a very desirable one to have in the shop.

* * *

KEEP THE SHAFTING CLEAN.

It is very little trouble to keep the line shafting looking bright and clean, and it helps to keep the accumulated dust and dirt from working into the bearings. A wiping with a kerosened rag (waste is too apt to get caught in the pulleys) once a week will keep it nice after it has once been cleaned in good shape. A half hour every Saturday keeps the shafting in good condition, adds to the neat appearance of any shop and gives the men an incentive to keep the other machinery clean also. It will also be well to have the bearings themselves attended to, and while with the reservoirs and oil-cups in common use they do not need weekly oilings, these should be kept filled at all times, as too much dependence on cups that are empty means hot bearings.

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OCTOBER, 1894.

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Sven Anderson.	G. M. Dickie.	Fred H. Perry.
Leceister Allen.	W. D. Forbes.	W. B. Ruggles.
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C. H. Benjamin.	"Jarno."	L. S. Starrett.
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Every issue of MACHINERY during the coming year will exceed 10,000 copies.

Of course we have quite a number of new ideas to introduce in MACHINERY, and some of them, people tell us, are good; but what we don't know would still fill a large book, and therefore we welcome practical suggestions which will help us to make the paper an absolute necessity to every one connected with the machinery trades.

* * *

SEE WHAT OTHERS HAVE DONE.

After some little experience with college or technical school graduates who appeared to be ignorant of the past history of mechanics and steam engineering, by being very enthusiastic over "new" devices which were merely revivals of old ideas and plans, would it not be a good idea to provide a branch of Ancient History of Mechanics, so that students could learn what had been done, see the good as well as the weak points of the old ideas and be prepared to meet any inventor with the original plan, if any existed? Nor is this confined to colleges, but can just as readily be applied to the younger mechanics and engineers, and let a portion of their reading be a research of old devices, which will prove very interesting as well as instructive, and credit inventions nearer to the original users than is apt to be the case. By taking the time to look into previous inventions in the line of work in which you are engaged, you will be spared much useless labor and can then start from the point where the last man stopped, instead of going over the same ground and inventing the same devices as your predecessor. And in this connection it may not be amiss to speak of the too prevalent practice of going to extremes in mechanical construction for the sake of having something different from the other makers. This feeling has caused many of the mechanical monstrosities to spring into being, which usually represent time and money thrown away. Originality is to be commended, but there are limits to this commendation which should cease as we approach the ridiculous in mechanical construction.

* * *

In the encouragingly large pile of commendatory letters which we have received is one from a Western friend, who writes:

"I have received a copy of MACHINERY, which is an exceedingly attractive publication and full of interesting reading. If you can keep the paper up to the standard of the September number, success is assured."

Bless you, our standard is away above *that*. Give us time.

* * *

LOOKING BACKWARD.

When the year 1944 shall dawn upon this land, engineers will look backward for fifty years and wonder how their predecessors ever managed to run steam plants as tradition and history informs them was done in what they will then call "the olden time." They will wonder how it was ever possible for a man who was running a steam plant, when he had a little more steam than he wanted, to pull the furnace doors open while the damper in the stack was still wide open, thus allowing drafts of cold air to rush into the furnace and impinge on the crown sheets, causing them to contract and bringing greater strains to bear upon them than any reasonable steam pressure would cause—then be surprised to see the seams leak and cracks appear. And furthermore they will wonder how it was possible for men to continue such practices after their attention had been repeatedly called to their impropriety, when it was always just as easy to put on a little fresh coal and shut the furnace and pit doors, thus excluding the cold air, and at the same time checking the combustion of the coal, and consequently the formation of steam. Men will then no longer erect plants and in order to save the cost of a feed-water heater, pump cold water into their boilers and consider it economy—then wonder why it is that their boiler repair bills are so large, and why their boilers frequently leak badly. Boiler attendants will not be contented to allow their glass water gauges to become so foul that it is almost impossible to tell where the water level is, when by expending three minutes time each day in cleaning them they can be kept bright and clean; neither will they decline to use their gauge-cocks because when they open them the boiler fronts are bespattered with mud, but will blow the dirty water out of the boilers and clean out the connecting pipes, and thus be able to use the gauge-cocks at any time during the day without detriment to anything in the boiler room.

They will not build up a big fire, pump the boilers nearly full of water and then stop the pump, load up a three horse-power pipe, and get into some dark corner to smoke and sleep; but will fire light and frequently, keeping the water level as nearly constant as possible, securing

the best economy of fuel and avoid all danger from either too much or too little water.

The practice of allowing boilers to run for a year or more without cleaning will have become obsolete, as will also the plan of putting large quantities of some scale resolvent into them and then running them for a month without removing the accumulated mud and loose scale on the sheets over the fire, until they are burned or bagged because the water is not in contact with the iron.

When the millenium of which we are writing, shall have arrived, engineers will look backward and wonder how it was possible for their fathers to load down their safety valves until whatever steam pressure was needed to do the work could be carried without any regard to the ability of the boiler to withstand this pressure; instead of ascertaining in an intelligent way just what pressure could be safely carried, and then positively declining to exceed this safe limit, even though they lost their situations thereby. They will also wonder how the idea could be advocated by some that because a boiler is made of iron or steel it will stand any amount of abuse, instead of knowing that it could be overworked, strained and ruined, just as a man or a horse is, by trying to do more than they were able to. How they will laugh at the idea that certain forms of so-called safety boilers could ever have been considered safe from explosion.

In reviewing former practices in the engine room, these engineers will scarcely believe that there was a time when a large proportion of the men in charge of medium sized plants did not understand the steam-engine indicator and its uses, and that even some men who were in charge of large plants claimed to have no faith in the instrument or its readings, principally because they were ignorant on the subject, and found this a convenient way to cover up their own deficiencies.

When they are told that long ago many men called themselves engineers who knew nothing of the construction of an engine, who did not understand the nature of steam, and when their machines became deranged in even a small degree, were unable to readjust them, but were obliged to send to some engine builder for a man to make adjustments and start up the machinery—how thankful they will be that they did not live in an age when competent men were sometimes expected to compete with such ignoramuses and men who had sadly missed their calling.

When they listen to veterans with gray heads and snowy beards, while they tell of former times when men were employed to care for engines who knew no better than to use steel hammers to drive keys, who would take a 14-inch wrench to tighten up a small set screw, or use a Stillson wrench on the nuts which hold a steam-chest cover in place, or try to smooth up a grooved crank-pin with a piece of emery cloth, or cut oil channels to the extreme end of a crank-pin box and attempt to tighten up nuts on the bolts in flange joints under high steam pressures—they will hold up their hands in holy horror.

When they look backward for fifty years to the times when men would pack the stuffing-boxes of piston-rods by taking out the gland and putting in a ring of fresh packing, then screw the nuts down hard in an attempt to make a tight joint, instead of removing all of the old, hard, dry packing, filling the stuffing-box with new, and then screwing the nuts only tight enough to keep them in place; and when they would use tallow instead of good cylinder oil in their cylinders, or discard a well tried cylinder oil for an inferior grade because the price is less by a few cents per gallon—how they will despise men of such poor judgment.

These things and many more of like nature will be talked over, and in some cases stories of such ignorance and foolishness will be discredited, but we who are living at the present time know them to be true. Is it not a good time now to begin a reform movement?

POINTS IN MACHINE DESIGN.

JOINTING BOXES—VENTING OIL-HOLES.

"JARNO."

Among the points that are of interest for a young mechanic to learn early, and to remember both early and late, I would suggest the method of rabbeting at B *b*, Fig. 2.

Pieces joined together in couples are often rabbeted as at A *a*, Fig. 5, which is equivalent to having one tongue in one piece and one groove in the other, thus requiring two gangs of cutters to mill.

In a better way, Fig. 2, each piece has a tongue and a groove, B *b*, and both pieces are milled with only one gang of cutters.

To mill two tongues in one piece and two grooves in the other, which is sometimes done, two gangs of cutters are required, and additional care is needed to space the cutters so that the tongues and grooves shall be equidistant. Fig. 2 requires no care in spacing, and it also has other advantages.

In Fig. 1 is a gang of cutters, G, milling a piece, P. Being

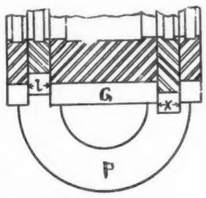


FIG. 1.

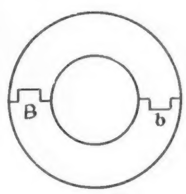


FIG. 2.

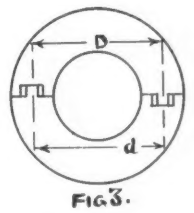


FIG. 3.

milled with the same gang, every piece is the same, and, though joined together in couples, there is no pairing other than to assemble any two pieces as they come. Gascon's chief draughtsman, Werner, designed Fig. 2, and having checked the drawing, sent it into the shop; from it a lot of pieces were made. Gascon objected to them chiefly because he thought that cutters for them would cost more than those for Fig. 5, and so he ordered a new drawing. But the workman that had made the pieces suggested that they were better than Fig. 5; and having listened to the suggestion, Gascon finally adopted Fig. 2.

Werner had designed better than he knew. To mold both pieces with one pattern, and to mill them with only one gang of cutters, had been his aim. He had accomplished both these, and, in addition, had locked the two sides B and *b* of the lower piece to those of the upper, each to each, so as to hold in both directions sideways. In Fig. 5 each side, A or *a*, holds in only one direction. Another advantage of Fig. 2 is that the pieces can be put together in only one way, and, when once right, must always come together right. The only special care in making up the gang of cutters is that *l*, Fig 1, shall be of the same thickness as *x*.

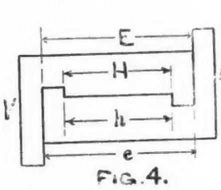


FIG. 4.

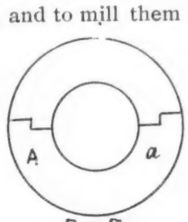


FIG. 5.

The reason why the distance between the tongue cutter *l* and the groove cutter *x*, Fig. 1, does not affect the coming together of the pieces, milled with the same gang, can be seen in Fig. 3. If the cutter *l* be thicker than *x*, of course the tongue will not go into the groove; if *l* be too thin the tongue will be too narrow, as in Fig. 3; but in either case the distance D is identical with *d*. This principle can also be seen in Fig. 4, in which E is identical with *e*, and H with *h*, while at the same time the two pieces K and *k* are identical when placed side by side.

Mephit says this is an old idea with him, but so far as I know it

originated in the works of Brown & Sharpe. Mephit is an adept at nosing old ideas.

A sight feed is a great safeguard in oiling, very important also is a vent to let the air escape so that oil can reach the bearing. In heavy machine bearings the oiling is usually carefully attended to, but the point that I wish to suggest is that in lighter machinery nearly all bearings, even the smallest, should have vented oil-holes, and that they should be clearly shown in the drawings. If a bearing has shoulders, an oil-groove can run the whole length of the box into the vents L L, as in Fig. 6, which also serve to oil the shoulders. If a bearing does not have shoulders, the oil-groove should not run quite the whole length of the box, and there should be two oil-holes, M M, Fig. 7, so that one will vent while the other fills. If a sight feed is a safeguard so also is a sight vent.

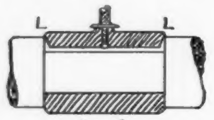


Fig. 6.

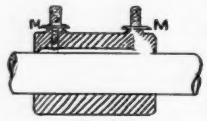


Fig. 7.

When the oil-hole bosses are smaller than the shoulders of the stoppers, as at M M, Fig. 7, dust is not so likely to collect around the holes and be wiped into the bearings.

In doweling two steel pieces that are to be hardened, we can not be sure that the spacing of the dowel-holes will not be changed in hardening. It has been found convenient to drill holes larger than the dowels are to be, and after hardening drive soft plugs into the holes. The pieces can then be matched and the dowel-holes drilled in the soft plugs.

* * *

FORTY-FIVE TESTS OF MALLEABLE IRON.

Geo. L. Fowler.

Some time ago an editorial article was published in the Journal of Railway Appliances in which the position was taken that for "commercial purposes, malleable iron can only be made and guaranteed in thickness not to exceed three eighths of an inch;" though it was acknowledged that metal to the thickness of 1¼ inch had been completely malleableized. Immediately after the appearance of the article referred to, there was an outcry on the part of several manufacturers, protesting that the capabilities of the industry had been mis-stated, and that complete malleableization could be readily and easily obtained with any thickness of metal that might be required. For the time they silenced opposition, but failed to convince. Careful inquiries, however, have merely tended to strengthen the position taken in the editorial referred to, and in no instance have we found that makers are willing to guarantee a complete malleableization to the center of pieces exceeding a thickness of ⅜ inch.

For the sake of clearness let us recapitulate the qualities of malleable iron. As it comes from the mould it is a hard, brittle casting, high in carbon, and with that carbon combined with the iron. It is then annealed and decarbonized by being packed with scales or hematite powder and subjected to a high temperature for a longer or shorter period of time dependent upon the thickness of the pieces to be operated upon. And just here let us call particular attention to the difference between malleableizing and annealing. The former consists in abstracting a portion of the carbon from the iron and thus giving it more of the qualities that are usually assigned to wrought iron. In other words, it of necessity becomes soft and ductile. Annealing, on the other hand, is merely a rearrangement of the molecules of the metal, so that the latter will be soft, but it does not necessarily involve any chemical change. These two terms are sometimes confounded even in the minds of those who should know better, and we have in mind now one particular manager who protested that the iron was annealed to its core, and scouted the idea of chemical change.

Again we were unable to obtain any information relative to the tensile strength of malleable iron. The best we could touch was that it was about as strong as steel castings and twice as strong as cast iron; statements about as definite as "the size of a piece of chalk."

Malleable iron manufacturers may know the strength of their wares, but we were unable to ascertain it, though the reason is difficult to comprehend as there is nothing to be ashamed of.

With this state of affairs before us we decided to investigate the physical properties of malleable iron for ourselves, and give our readers the benefit of our researches. We therefore had pat-

Test specimen from C. See note above.

Finished specimen, showing absence of shell.

Test specimens from C, showing greater thickness of shell than in others.

TEST SPECIMENS OF MALLEABLE IRON, SHOWING THE AVERAGE THICKNESS OF SHELL RELATIVELY TO THE DIAMETER.

terns made for test pieces of malleable iron. The test portions being 8 inches long and 3/8 inch, 1/2 inch, 5/8 inch, 3/4 inch, 1 inch and 1 1/4 inch in diameter respectively, as ordered, though the diameter of the castings varied slightly therefrom, as indicated on the table. Two castings were ordered from each pattern, and from each of five makers. One complete set was tested in the rough just as they came from the foundry, and the other was turned down, so as to ascertain the difference existing in the tensile strength of the interior and the external shell or scale. These were ordered to be turned as follows: The 3/8 inch specimens were ordered turned to 1/4 inch; the 1/2 inch to 5/16 inch; the 5/8 inch to 3/8 inch; the 3/4 inch to 1/2 inch; the 1 inch to 11/16 inch and the 1 1/4 inch to 7/8 inch. The sizes to which they actually were turned is given on the table. Owing to the inevitable trouble that always comes in turning malleable iron, a large number of these specimens were spoiled, so that the results were not as complete as could have been desired, though they were sufficient to show what can be expected. The tests were made on a machine of 100,000 lbs. capacity, built by the Riehle Bros. Testing Machine Co., of Philadelphia, Penn., and the work was done in their laboratory. Micrometer measurements were taken of the diameters of all test pieces before they were put in the machine, and those given for the rough specimens are the smallest that could be found along their lengths. All specimens, with one exception, were straight. The following are the table of physical properties of the specimens tested:

TABLE A.—TESTS OF ROUGH SPECIMENS.

Maker.	Size in inches; diameter.	Area in sq. inches.	Broke at in lbs.	Strain per square inches in lbs.	Limit of Elasticity in lbs.	Limit of Elasticity per sq. in. in lbs.	Elonglation in 8 inches.	Elongation per cent in length.	Remarks.
A...	.424	.1412	6,770	47,946	5,000	35,411	.31	3.87	Cast from 3/8 inch pattern.
B...	.435	.1486	6,550	44,078	4,850	32,638	.22	2.75	
C...	.437	.1500	7,750	51,667	5,550	37,000	.29	3.62	
D..	.449	.1583	7,250	45,799	4,800	30,319	.38	4.75	
E...	.428	.1439	6,400	44,475	5,100	35,441	.23	2.87	
A...	.526	.2173	10,770	49,563	8,120	37,368	.32	4.00	Cast from 1/2 inch pattern.
B...	.512	.2059	9,460	45,945	7,120	34,580	.19	2.37	
C...	.513	.2067	10,200	49,347	7,300	35,317	.30	3.75	
D. .	.527	.2181	9,900	45,392	(?) 8,800	(?) 40,348	.31	3.87	
E...	.522	.2140	8,900	41,589	8,650	40,421	.17	2.12	
A...	.653	.3349	14,930	44,580	....	....	.31	3.87	Cast from 5/8 inch pattern
B...	.660	.3421	14,230	41,596	10,200	29,816	.20	2.50	
C...	.651	.3329	14,510	43 587	10,540	31,661	.25	3.12	
D...	.659	.3411	13,430	39,373	10,930	32,073	.15	1.87	
E...	.656	.3380	13,700	40,532	10,150	30,029	.17	2.12	
A...	.798	.5001	21,780	43,551	13,300	26,594	.27	3.37	Cast from 3/4 inch pattern.
B..	.803	.5064	19,700	38,902	15,100	29,818	.17	2.12	
C...	.798	.5001	25 560	51,110	13,800	27,594	.30	3.75	
D ..	. 09	.5140	21,600	42,023	15,700	30,545	21	2.62	
E...	.793	.4939	20,720	41,952	15,850	32,091	.17	2.12	
A...	1.035	.8413	34,270	40,735	22,000	26,150	.22	2.75	Cast from 1 inch pattern.
B...	1.036	.8431	31,100	36,887	23,200	27,517	.12	1.50	
C...	1.009	.7996	37,630	47,061	22,100	27,638	.26	3.25	
D ..	1.018	.8139	35,800	44,084	21,900	26,907	.20	2.50	
E...	1.013	.8059	33,700	41,816	....	....	.19	2.37	Specim'n bent
A...	1.281	1.2888	58,000*	45,003	29,900	23,200	.35	4.37	Cast from 1 1/4 inch pattern.
B...	1.285	1.2969	48,400	37,320	34,780	26,818	.16	2.00	
C...	1.264	1.2549†	42,450	33,827	31,600	25,181	.10	1.25	
D. .	1.290	1.3070	50,850	38,905	33 530	25,654	.15	1.87	
E...	1.291	1.3090	46,680	35,661	31,150	23,797	.17	2.12	

* Stopped under a strain of 56,665 lbs. for two minutes.

† The area given is for a full diameter, while in reality, at the point of fracture, there was a crack extending into the metal 0.13 in., thus reducing the area to 1.183 square inches and raising the breaking strain to 35,883 lbs. per square inch.

TABLE B.—TESTS OF TURNED SPECIMENS.

Maker.	Size in inches: diameter.	Area in sq. inches.	Broke at in lbs.	Strain per square inches in lbs.	Limit of Elasticity in lbs.	Limit of Ellsticity per sq. in. in lbs.	Elongation in 7 inches.	Elongation per cent of length.	Remarks.
C...	.249	.0487	1,450	29,774	1,120	22,998	.06	.85	Turned from 3/8 in. diam.
A...	.400	.1257	3,470	27,005	3,240	25,775	.07	1.00	Turned from 5/8 in. diam.
C...	.400	.1257	4,000	31,822	3,030	24,105	.12	1.81	
D ..	.398	.1244	3,670	29,501	3,016	24,244	.11	1.57	
A...	.500	.1964	6,250	31,823	5,630	28,660	.10	1.43	Turned from 3/4 in. diam.
E...	.500	.1964	6,100	31,059	5,330	27,138	.05	.71	
A...	.687	.3707	13,380	36,094	10,780	20,080	.16	2.28	Turned from 1 in. diam.
B...	.687	.3707	10,950	29,539	10,390	28,028	.07	1.00	
C...	.687	.3707	15,050	40,599	10,450	28,190	.39	5.57	
D ..	.687	.3707	12,100	32,641	10,600	28,594	.09	1.28	
A...	.875	.9613	23,310	38,766	18,950	31,515	.25	3.57	Turned from 1 1/4 in. diam.
B...	.875	.6013	18,140	30,168	....	....	.10	1.43	
C...	.875	.6013	21,510	35,772	16,500	27,773	.33	4.71	
D. .	.875	.6013	20,100	33,427	16,750	29,519	.17	2.43	
E...	.875	.6013	10,400	17,296	....	....	.02	.28	

If we summarize these results and take the averages of the whole, we obtain the following table:

TABLE C.—SUMMARY OF RESULTS.

Original diameter of test piece.	Tensile strength in lbs. per square inch.		Percentage of loss due to turning.
	Rough.	Turned.	
3/8 inch.....	46,793	29,774	36.4
1/2 inch.....	46,367	....	....
5/8 inch.....	41,934	29 643	29.4
3/4 inch.....	43,508	31,441	27.8
1 inch.....	42,117	34,718	17.6
1 1/4 inch....	38,143	31,085	34.4

While the number of test pieces used in these experiments have not been large enough to formulate results from which accurate formulæ can be deduced, and the work labors under the disadvantage of coming from different makers, using different mixtures of iron and heating for different lengths of time in the ovens, the general statement may still be made that the strength of malleable iron decreases as the thickness is increased, and the internal core is about 28 per ct. weaker than the external shell.

If we examine the elongation in percentage of length we also find an unexpected difference in behavior of the turned and unturned specimens. These may be compared as follows:

Original diameter of piece.	Percentage of Elongation.		Original diameter of piece.	Percentage of Elongation.	
	Rough.	Turned.		Rough.	Turned.
3/8 inch....	3.57	.85	3/4 inch....	2.79	1.07
1/2 inch....	3 23	....	1 inch.....	2.47	2.53
5/8 inch....	2.68	1 43	1 1/4 inch...	2.34	2.48

Here the elongation of the turned specimens is greater than that of the rough on the larger diameters. And furthermore, the limit of elasticity follows the same rule, being less for the small specimens and greater in the large.

In making these tests there is one important feature that can not be given in the tables, and that is the behavior of the specimen in the machine at the moment of rupture. With the rough specimens there was in every case a violent recoil and an explosive parting, while with the turned specimens the rupture was gentle and quiet, with almost no recoil, as though a cotton string had been burned in two. It will be noticed, too, that the limit of elasticity of the turned specimens approaches the breaking strain after the manner of cast metals.

In making deductions from these tests we are well aware that the data is somewhat meagre and in some cases conflicting, probably for the very reason that it is meagre. Especial care should also be taken to avoid haste in stating the scale to be stronger than the interior, for that is also markedly the case with rolled wrought iron. As for the chemical composition we frankly admit that we have no knowledge of it, but expect to have analyses made which will be published in a future issue. With these reservations, we think that the results of these tests point to the conclusion that there is a better malleableization of the exterior of the specimen than of the interior, and that the strength is, therefore, deteriorated by turning. Malleable iron shows a greatly superior strength over cast iron, and for equal areas may safely be rated at about two and a half times that metal; so while it is not customary to load cast iron to more than 6,000 lbs. per square inch, malleable iron may safely be loaded to 15,000 lbs. without danger of exceeding the limit of elasticity or endangering the metal.

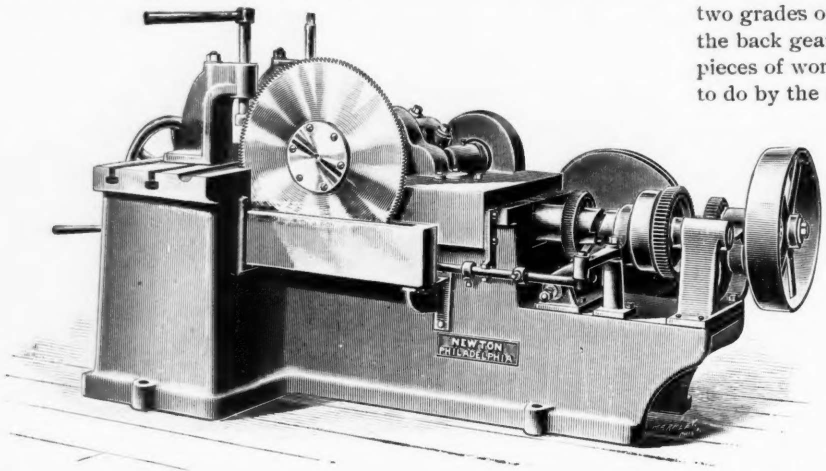
We wish to call especial attention to the engravings of fractures that accompany this article. One set shows the complete set of rough fractures made by C, which gave the best results throughout the series. The white metal ring, decreasing in thickness as the diameter increases, shows the depth of the shell. The other specimens show the depth that obtained on the average of the lot. That the depth of this shell, or the malleableized portion, as it is ordinarily called, has an influence on the strength and ductility of the specimen there can be no doubt, but as to what difference there exists between its chemical composition and that of the darker core we are not prepared to say; but this much is at once evident, that the large diameters show the thinnest shell.

* * *

THERE are very few shops that haven't some useful kinks, special tools, etc., which would be of use to others, but being accustomed to them the men think everyone else must know it also. This is a mistake. The kink-growth is so various, according to climate and ingenuity, that every shop has a different species. Let us have yours.

BAR COLD SAW CUTTING-OFF MACHINE.

The illustration presented herewith is of a new cold saw cutting-off machine for cutting bar steel or iron. The machine has a saw or hollow ground milling cutter 30 inches in diameter and will cut off round stock up to 9 inches diameter and square stock up to 8 inches; it can also be used for flat or irregular bars within the capacity of the machine. For ordinary cutting the bar is laid under the clamps on the V groove and the carriage carrying the saw is fed forward at the desired feed for the work; the feed is regulated with a lever, which operates the friction roller, and by a motion of the lever the roller can be placed so as to obtain any feed from 1½ to 2 inches per minute. By removing the clamps on the work-table irregular work can be clamped with the ordinary bolts and cut-off; this is especially convenient for forging work, and can also be used for cutting-off work at an angle, such as rails for crossings, etc. The spindle of the machine, which is very large, is driven with a train of cut steel spur gears and phosphor bronze worm wheel, with hardened steel worm, the thrust of the worm being taken up with combination thrust collars of hardened steel and phospher bronze. The machine is

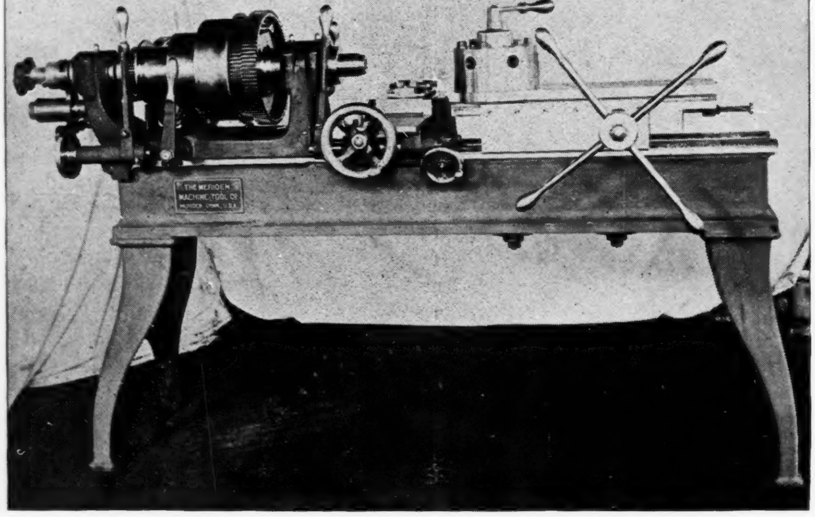


classed as the No. 4 bar cold saw cutting-off machine, and is built by the Newton Machine Tool Works, of Philadelphia, who build this style of cold saw cutting-off machines in eight sizes, with saws ranging from 10 inches to 58 inches, and with capacities from 2 inch up to 18 inch round stock.

* * *

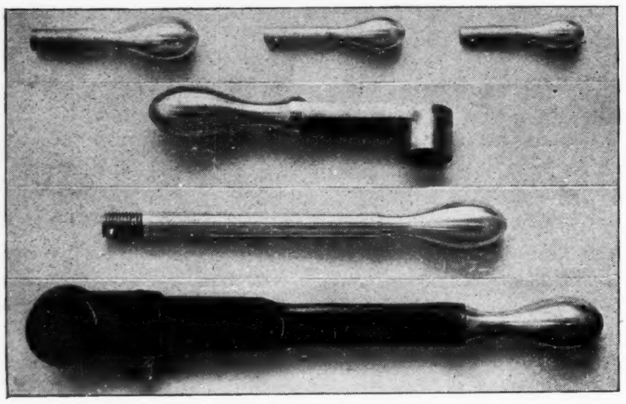
A NEW TURRET LATHE.

A few years ago a certain man astonished the silver plated ware manufacturers of Meriden, Conn., by taking jobs of turning all their ornamental tips, pillars, bottle-tops, etc., at prices far below those at which they could be done for in their own factories; in addition to this the work was better in every respect. The natural question was, "How does he do it?" It was finally discovered that he had a special machine, and this machine was the first *forming lathe*.



Some time after this the firm, which is now succeeded by the Meriden Machine Tool Co., began manufacturing forming lathes for the market, and as their system of finishing metal to ornamental and specific shapes became better known, it became necessary to meet new conditions, so that whereas the lathe was at first used only for turning britannia and the soft metals, it is now beginning to be extensively used on all kinds of brass work, such as injector and valve parts, steam pump trimmings, plumbers' goods, etc., and it will be seen by reference to the collection of handles shown that the makers of the lathe find it to their advantage to use it on their own work, by turning all the handles on the forming lathe in the forming lathe itself.

The latest lathe brought out by the company is shown in the accompanying cut, this being a double back-geared lathe, giving



two grades of back-gear speeds, beside the quick speeds without the back gears, and it is now possible to do on this lathe many pieces of work that not long ago were thought to be impossible to do by the forming system.

This lathe includes the double tool improvement lately brought out by the company, by means of which the work is roughed out by a first tool, and thus prepared for a very light finishing cut by the second tool, all at one movement of the slide; the result of which is better work than has ever before been produced by forming, or any other method whatever.

For further particulars address the Meriden Machine Tool Co., Meriden, Conn.

* * *

ONE of the hardest items of shop expense to economize is that of files. Many are wasted or not half worn out, especially in brass work, but when we restrict the number too closely we are apt to lose in the time taken to file a piece of work. It thus becomes a decision between the extra file expense in the first case, or the extra labor expense in the latter, and this can only be determined by actual experiment on the work involved. It is worth remembering, however, that a file which will hardly cut brass is practically as good as new on iron and steel, and by sending the old files from the brass department into the machine shop, good results are obtained.

A CURIOUS case of movement of the ground occurred at Concord Junction, Mass., recently. A boiler had been set up next to the wall, without much foundation, and remained in this position for over five years. At that time a trench was dug for gas pipes, forty-two feet away from the boiler and parallel with it, and this caused the boiler to settle towards the trench, leaving an opening next to the wall to show the distance moved. This shows the instability of the soil and the necessity for good foundations for any heavy boiler, engine or other machinery.

THERE should be one man around the shop who can make a good cemented splice joint in any belt from the main driver down to the one running the dynamo, this being one of the most particular places, owing to the necessity for absolute steady running. The spliced joint is not so difficult as it appears, and can be learned by any good man, even a helper, and is economical in the long run, especially for large and heavy belts.

ON THE RESISTANCE OF TRAINS OF MECHANISM.

Leicester Allen.

My attention has been directed to this subject by some recent shop experience which, while they have cost some time and money, have been fruitful in education. A train of mechanism of peculiar construction developed such remarkable resistance to motion that I was led to investigate the law of such resistances, in so far as they can be brought under a general law, and also to study some resistances that come into play in such mechanism: for thè computation of which the data, if obtained at all, must be obtained experimentally from the mechanism itself. As such experimentation presupposes the prior construction of the mechanism, there will be many who, when called upon to design new combinations of parts in mechanical trains, and being obliged to guess at the resulting strains to which the initial parts of such a train must be subjected in order to drive the entire combination, will much underrate them, and will make these parts so weak that they will fail when put to actual service. They will be less likely to make such a mistake, however, when the law of accumulation of resistances is well comprehended.

Very likely this subject has been discussed by others in abler style than I can hope to achieve. If so, I did not know the fact before taking it up on my own account, and I do not now know where to look for such a discussion. I had to think the matter out for myself, and arrived at conclusions which will appear further on.

As it is a rule with me not to guess at anything in mechanical construction which can be accurately determined, even though the processes involved in such determination may be so tedious and laborious as to tempt one to neglect them, I sought to calculate in advance the strains in the mechanism referred to, but soon found that data were lacking on which to base computations. One element that increased resistance materially was the springing of certain slender shafts whose sizes could not be much increased for valid reasons.

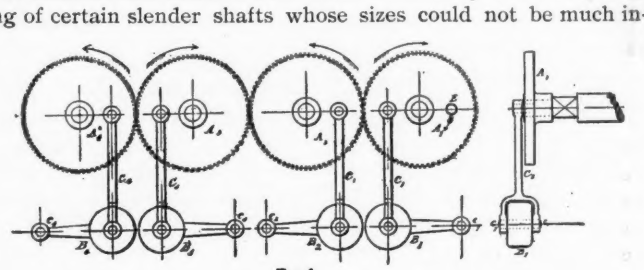


Fig. 1

The material of which these were made was drill-rod, and the physical data of tensile strength, rigidity, etc., necessary to exact calculations were lacking. Besides these data, the amount of power necessary to drive a single element of the train was yet an unknown quantity, indeterminable, till this element was constructed and made the subject of experiment. The difficulties in computing strains, and from these the necessary strength of parts which were to receive strains seemed so formidable that I resolved to waive a calculation in this instance and to proceed tentatively.

In the device I was constructing there were eleven elements (I will presently define what I mean by an element) in the train, each of which, in succcession, transmitted power to the next element in the series, and each of which was made up of six working parts, thus comprising sixty-six working parts. Some of these parts were actuated by springs, and the strength of the springs necessary to obtain the required quickness of action in parts moved by them after having been first moved against their resistance by other parts was, in advance, impossible to determine, since the weights of the parts were not known, and their forms were so irregular that it was nearly or quite impracticable to compute the weights with a near approach to exactness—the more so, as many of these parts, while required to transmit considerable power, were required to be quite small.

I have been thus explicit in stating the conditions which confronted me, because such conditions will be not unfrequently imposed upon others, and similar results might follow their first attempts as rewarded mine. The device when constructed was operative, but several of its parts were found to be too weak to withstand the unexpectedly great strain brought upon them in extreme cases. Those concerned in building the machine of which this mechanism is a part were, like myself, quite unprepared to expect the great increase of strain which resulted when all the elements of the train were operated together by power imparted to the first. As each element operated very easily by itself, and as four or five of them coupled serially together worked with apparent ease, yet, when more were added, the power required increased much beyond the increase of the number of the added elements, it became evident to me that there was a law of increase in mechanism of this sort which not only myself but the majority of mechanics had failed to properly appreciate. I therefore set myself to study with a view, if possible, to ascertain and formulate this law.

My esteemed friend, Mr. James Brady, at whose shop in Brooklyn the work of building the machine was in progress, did, indeed, predict that the power required to drive this train of mechanism was likely to much exceed our anticipations. This opinion was based upon his large experience with mechanism of the same class. The cause of the increase of resistance which he assigned was torsion of the parts which exaggerates normal friction. It was evident to me, however, that this by no means accounted for the increase, although it plays a considerable part in it when the power transmitted by one element to the next in the series is not transmitted in the same plane of motion, but in a plane at a considerable distance from that in which its driver acts

A train of mechanism such as I am considering is a series of parts so connected serially that driving power applied to the first of the series is transmitted by it to the second and from the second to the third, and so on. This may be done with the view of the performance of some useful function by the last of the series only; or some or all of the parts may perform useful work other than the transmission of power to the next in order. This will appear more plainly by reference to Fig. 1, which is one of the simplest examples of such a train. It represents a series of toothed gears, A_1 A_2 A_3 A_4, the first driving the second, the second driving the third, and the third driving the fourth. The direction of motion is indicated by the arrows. It is assumed that the function of useful work performed by each element other than that needed to drive the next element of the train is the lifting of the weighted end of the rock lever A_1 A_2 A_3 or A_4, which is connected with it by one of links C_1 C_2 C_3 C_4. The weighted rock levers are supposed to rock on the centers c_1 c_2 c_3 c_4. Any useful function may be supposed to be performed by the dropping of the weights after they are lifted. The first wheel A_1 may be supposed to be keyed to a tripping lever which, after being depressed a short distance, is suddenly released, thereby allowing the weights B_1 B_2 B_3 B_4 to fall and perform the function assigned to them. The repeated lifting and falling of the weights through the operation of the wheels in this way would then constitute the operation of this train. If the weighted levers B_1 B_2 B_3 and the links C_1 C_2 C_3 were disconnected, the function of the train would be to lift the weighted lever B_4. In the latter case, besides friction on the journal of the wheels, there would be friction on the bearings of the link C and on the journal of the rock-lever B. In case all the rock-levers are coupled on, each of the elements will have five places where friction will be generated, counting in the teeth of the wheels; and as the two intermediate wheels each mesh with two wheels, these will have six places where friction will be generated. In complicated trains of mechanism there may be even more than this, and the proportion of total power consumed in friction in driving only a detached single element may be considerable, often amounting to 30 per cent., or more. If such a train be at rest, and force be applied to start it, besides friction, the inertia of the parts will develop resistance, which will be greater or less according to the weight of the parts and the velocity with which they are put in motion.

In the train shown in Fig. 1, if power be applied at the perimeter, the leverage would be in favor of the driving force. I shall first treat a case like that shown in Fig. 1, which is not complicated by leverage. If power be applied at the crank-pin E to turn the wheel in the direction indicated by the arrow, the radial distance from the center of the wheel to the center of the crank-pin being the same as that from the center of the wheel to the center of the link-pin, and the latter being the same for each wheel in the train, there will be leverage neither in favor of the force that moves the train, nor of the resistance to be overcome. Also, in our first approach to the subject, it is desirable to eliminate considerations of inertia and velocity and all consideration of torsional stresses; and, as in the arrangement shown in Fig. 1, torsional strain is reduced almost to zero, it will be the best for illustrating the increase of force due to friction only. If we consider that force applied at E is so slowly applied that the motion produced by it is barely sensible, the consideration of

inertia and velocity may be dispensed with. Also, if we consider that the power is applied to lift the weights through a very small arc, we may assume that the angularity of the connections between the weights and the wheels which lift them remains sensibly unchanged. The resistance to movement is now wholly frictional, and we are to inquire what is the law of increase of the force necessary to start the train into movement under these conditions.

* * *

MILLNG MACHINES AND MILLING CUTTERS.

W. L. Cheney.

In these days when everybody has the milling machine craze, some practical hints regarding the selection of cutters, etc., may be acceptable.

It is pretty well agreed that the *surface* speed of a milling cutter should be, generally speaking, about 35 feet per minute for ordinary steel, and 40 feet per minute for ordinary cast iron.

As milling cutters are usually thought of as being a certain number of *inches* diameter, it will evidently simplify matters to reduce 35 feet and 40 feet to inches also, as follows:

$$35 \text{ feet} \times 12 = 420 \text{ inches}$$
$$40 \text{ feet} \times 12 = 480 \text{ inches}$$

It is evident that we can divide 420 inches, or 480 inches, as the case may be, by the number of inches *around* a certain cutter, that is by the number of inches in the *circumference* of the cutter, and thus get the number of revolutions per minute that it is necessary for the cutter to make in order to get the theoretical 35 feet or 40 feet *surface* (or periphery) speed.

But as the circumference of any circle is 3.1416 times as much as the diameter, it is easier and saves much time in the long run to divide the 420 inches or the 480 inches, as the case may be, by 3.1416, and keep this as a constant quantity representing *diametral* speed (if such an expression may be allowed) of the cutter, and *this* quantity by the number of inches in the *diameter* of the cutter, instead of dividing the actual number of inches in 35 or 40 feet by the actual number of inches in the *circumference* of the cutter.

When this is understood, we can easily proceed to the construction of a rule or formula, as follows:

$$\frac{420}{3.1416} = 133.69 \text{ and } \frac{480}{3.1416} = 152.79. \quad \text{Therefore}$$

$$\text{No. of revolutions of cutter for 35 feet} = \frac{133.69}{\text{diam. of cutter in inches}}$$

$$\text{and No. of revs. of cutter for 40 feet} = \frac{152.79}{\text{diam. of cutter in inches}}$$

and from this again we can easily construct a table of sizes of cutters likely to be used on medium sizes of milling machines, as follows:

Diameter of cutter in inches.	Revolutions per minute necessary for 35 feet surface speed per minute.	Revolutions per minute necessary for 40 feet surface speed per minute.	Diameter of cutter in inches	Revolutions per minute necessary for 35 feet surface speed per minute.	Revolutions per minute necessary for 40 feet surface speed per minute.
⅜	357	407	1¾	76	87
½	267	306	2	67	76
⅝	214	244	2½	53	61
¾	178	204	3	45	51
⅞	153	175	3½	38	44
1	134	153	4	33	38
1¼	107	122	5	27	31
1½	89	102	6	22	25

Now for the practical application: A certain back-geared milling machine which we will use for example, has a total of six speeds, as follows: 28, 40, 62, 106, 160 and 240 revolutions per minute; comparing these speeds with the theoretical speeds in the above table, we find the nearest regular diameters of cutters proper, to be used on cast iron, to be: 6, 4, 2½, 1½, 1 and ⅝ inches; or for steel, 5, 3½, 2, 1¼, ⅞ and ⅝ inches.

It will thus be seen that, *on this particular machine*, we have no *theoretical* use for a cutter of 3 inches diameter, for instance; but *practically* we may be forced to use such a cutter, and the only thing we can do is to run an intermediate speed, with the result that we are either not doing as much work as we could if the speed was just right, because we are running too slow, or that we are wearing out cutters, and running up grinding expense, because we are running too fast, and this points to the conclusion that the perfect milling (or other) machine of the future will have a *true cone* arrangement, or something that will accomplish the same result, *i. e.*, the possibility of getting *any* speed between the extremes, instead of going by jumps, as it is now necessary to do with the *stepped* cone.

Another thing, which is true, as far as I can see, of any machine driven by any arrangement of cones, is that the power is smallest at the very time when it is needed to be greatest; that is, with the largest cutter, which needs the most power, the belt speed is slowest, which gives the least power. It follows, then, that on milling machines, as at present constructed, with cone pulleys as drivers, *the smallest diameter cutter that will reach the work* should be used, because it will have *more power* back of it, and will therefore do more work, and beside all this, as most milling machines are constructed, it is impossible to get *feed enough* when the machine is run slow for large cutters, because the range of feed cones is nowhere as near as large as the range of the main driving cones, when it should be very much greater, to have a machine anywhere near perfect in design.

* * *

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

BENDING COPPER PIPE.

Mr. Hobart's note on pipe bending is good, but an addition to it may well be made. Many coppersmiths fill the pipe to be bent with dry river sand, plugging up the two ends tightly with well fitted wooden plugs. The sand prevents buckling and makes a filling almost as good as rosin, without the danger incident to remelting and pouring out the rosin. At the Baldwin Locomotive Works, rosin filling gave way to sand, and the sand was displaced in some instances by coils of steel wire, preferably of square section, the coil of spiral spring being attached to a rod to adjust the spring to the part to be bent. C. S.

HARD ON THE MODEL-MAKERS.

There is one feature in connection with the model-makers' business that seriously affects the general trade in the matter of prices. A man goes to the model-maker and has a model of a new electric conduit railway built, and of course pays handsomely for the experimental work, for such work is always expensive. The question of putting the device on the market in full working size next comes up, and the promoters say: "Now, Mr. Model-maker, you have an idea of the expense from this model and we want an estimate as to cost of this conduit for full working size." "Well, Mr. P., of course the building of this on a large scale is out of my line: I can't do it, for I haven't facilities; but that ought to to be built for—let me see—about $5.00 a foot. Thus the model-maker sets the price (usually very low, for he knows he won't build it) for others to work to, and any one who wants a higher price is told that "there has been one bid at $5.00 per foot," when in reality the model-maker wouldn't bid on it at any price. The promoters, usually not mechanics, make estimates on the cost per mile, etc., based on the model-maker's figures, and as a result get badly left when they come to build an "experimental mile," if they ever get so far. If the model-maker would refrain from "guessing" (for that is all he does) at the cost of such things, it would be better for all concerned, for the general machine builder as well as the promoter, for he would not make such wild estimates as is now the case.

Superintendent.

ABOUT BUCKEYE ENGINES.

Will some one well posted on Buckeye engines tell me why these engines will not run well condensing? A friend of mine who has run them for years says the valves are made with such short lap that you cannot cushion enough to get a quiet running engine when a condenser is used, but for non-condensing they are all right. He had brass strips riveted on the valves to give them more lap, then reduced it till they were right by the indicator, and the engines run nicely now. It seems strange that they are not made with sufficient lap to run quietly, but my friend says they do not. W. L. Jones.

DRAWING SPECIFICATIONS.

I want to call attention to what seems to me a very unjust feature of the competitive bidding for work to be done or appliances to be installed, and much of it lies with the architect or whoever draws the specifications. For example, the specifications for a

lighting plant in a large factory were so drawn that nothing but Edison machines and appliances could be used, and in another plant not twenty-five miles away the only machine that could comply in every detail were those made by the Westinghouse Electric Co., although both specifications were apparently fair and equitable, but contained some little feature which made one system or the other a necessity. This, of course, lays with the architect or engineers, and leaves them open to the charge of being interested financially in throwing the contract to one or the other. One firm of architects and builders with whom I am acquainted, control a number of patented specialties used in large buildings, and always draw their specifications so as to compel the use of these, and practically preventing competition from outside builders. The remedy would seem to be to have specifications drawn by parties who are thoroughly disinterested, if such can be found, but if honest competition is desired this practice must be broken up. H. A. Wood.

TIMES HAVE NOT CHANGED.

I often think of an old engine on our road that had too many designers—that was all that ailed her—but it is typical of some cases to-day in machinery as well as railroading. She was a 16 by 24 inch cylinder, eight wheeler, with 5 foot drivers, and a patent fire box, patent nozzles, patent stack, brick arch and a six weeks' travel on the valves, and although she looked nice and had the best of coal, she was not a howling success. The superintendent had designed her valves, his assistant had patented the nozzles, the master mechanic had recommended the stack, and the vice-president wanted the fire box and brick arch; so we had all shades of opinions—sort of a mechanical hash on wheels, but the engine didn't run to suit the road foreman, who hadn't had a finger in the pie at all. He knew, however, if he made any changes, the backer of the particular device changed would object in no gentle way; so he simply requested that the assistant superintendent should ride on the engine and make what changes would be needed to help her. It took only one trip to convince him that the stack wasn't suited to the engine; the nozzles were working splendidly, but the stack didn't agree with the draft, so he recommended changing the stack and possibly taking out the brick arch. The master mechanic went over the road next day, and the only thing that prevented that engine from beating the world was the nozzles (too low and not the right shape inside, beside being too small), and with that valve travel you couldn't keep fire in her. This aroused the superintendent, and he vowed (strong vow) that if he couldn't fix her so that she could make time he'd take off all the improvements and make her like the old engines—that is, only leave the valves—for any one who knew anything about valve gears and locomotives knew they would help any engine.

The vice-president wasn't much of a mechanic, but his son-in-law had patented the fire-box and brick arch (was just three-eighths of an inch different from the one we had used before), and as he said it would make lots of steam with little or no coal, and without smoke enough to see with a microscope, the vice-president swore by the furnace end of the engine. All the rest of the improvements might not be of any use, or might even be a detriment; but that furnace saved her from being a total wreck. After all the recommendations had been made we began to experiment: the nozzles were changed, to the delight of all but the assistant superintendent, but she didn't howl even then, to his intense satisfaction.

Then the stack suffered, the valve travel was reduced and she seemed improved, the superintendent declaring the change of stack had done it—"If they had only left those valves alone," while the master mechanic sang a similar tune in the opposite key. So things went till finally the president got his back up, and ordered a new engine just like her, only *leaving off all the various improvements*, and that engine is running to-day, giving good satisfaction.

No! I don't mean that we shouldn't improve our engines all we can, but doesn't it seem folly or worse to make so many changes, that even if the engine is improved, you don't know which portion to credit with it? R. E. Marks.

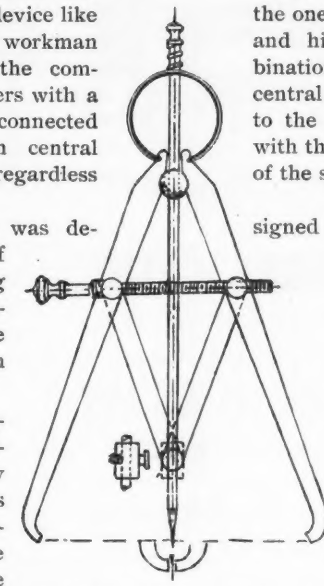
* * *

The grinding surface, whether in the form of a wheel, disc or plate, must be kept true if good work is to be done. Any high spot on the wheel makes a jar on the work, and acting as a blow tends to force it away from the wheel, producing very uneven work. This is one of the reasons why the grinding machine is not more fully appreciated.

MACHINERY'S NOTE BOOK.

"LAYING-OUT" CALIPERS.

Special tools are required for the rapid production of work of any kind, and even in laying out work for drilling, where jigs are not economical on account of small quantities made, a little device like the one here shown will help both the workman and his employer. As will be seen, the combination is simply a pair of spring calipers with a central scriber or scratching point, so connected to the caliper-legs as to always remain central with them, so as to scribe a central line regardless of the setting of the caliper.



The caliper was designed by Mr. Harry P. Cathcart, of Philadelphia, to facilitate laying out holes accurately and rapidly, and the object seems to be neatly attained by the design submitted.

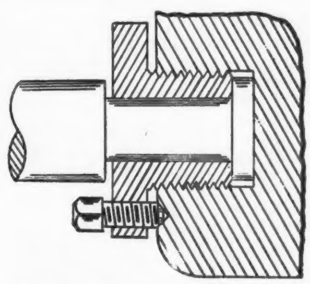
*

Do not forget that the younger generation of mechanics know little or nothing of the methods employed in machine shops forty or fifty years ago, and, while much has been told, there are many little ingenious devices and kinks that were used to advantage "in the old days." Perhaps the opportunity or necessity for using the device may have passed, but it probably contains an idea from which another useful tool may grow, for the younger mechanics have lost none of the ingenuity of the craft, although not always afforded the opportunity for displaying it as frequently as before special machines were built for nearly all kinds of work.

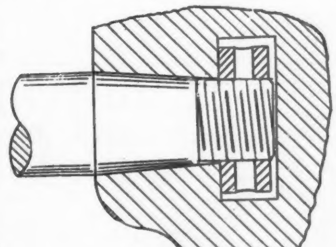
* * *

FASTENING THE PISTON ROD.

There is little doubt that the old method of keying the piston-rod into the crosshead has been responsible for many broken rods and accidents resulting from them. Given a key with a slight taper, a strong man and a heavy hammer and who can calculate the strain exerted in the keyway of the piston-rod tending to tear it apart; and there is little doubt that many a rod has been strained to nearly the breaking point before it ever felt steam pressure, taking but a small load to complete the destruction.



With this in view there have been many methods devised for doing away with the key, the Pennsylvania Railroad adopting the first method shown, on their new class "P" locomotives The crosshead is tapped for a nut, as shown, the rod being turned down to leave a collar at the back end. The nut, which is in halves, is put around the rod, screwed home till it locks the collar against the crosshead, and held in position by the cone-point set-screw in countersunk holes for the purpose. The next method has been in use on the Manhattan Elevated Railway for some time, and is very much liked by the men, the round nut in the recess draws the rod to a taper fit, pin-holes being provided for turning the nuts. Neither pin wrench nuts nor split nuts can be said to exactly satisfy mechanical requirements, but they are so far ahead of the key in this respect that comments are unnecessary.



LINING PUMP BARRELS.

A neat method of lining pump barrels with brass was devised some years ago by Mr. Frank E. Harthan, of Worcester, Mass., and is used by the Wheelock Engine Co. of the same place.

Instead of casting a bushing, or going to the expense of having

a large tube drawn, to be forced in and bored; the barrel is bored to the right size to receive a bushing of a certain thickness. A sheet of brass of the required size and a little thicker than the allowance is rolled up, shoved into the barrel and the whole placed on the cylinder boring machine. Here it is rolled tightly into place and literally swaged to the required thickness by using a smooth burnisher instead of a cutting tool, although in some instances a light cut is taken after the bushing is fully rolled into place Slight riveting on the ends prevents any possibility of loosening and makes one of the neatest jobs imaginable.

TRUE ECONOMY.

Tests of engines and machinery are doubtless of great value in determining their maximum capacity or economy, but we are too apt to assume this as its regular performance and make calculations accordingly, only to be disappointed when the average running falls considerably below.

In many instances where highly successful tests have been run, the subsequent breaking or derangement of machinery, due to smallness of parts or poor design, has been so expensive as to offset the economy of the test even if continued in daily practice, making the question of true economy one which must alone be solved by continuous running, not by spurts and starts, followed by idleness or breakdown.

The uneconomical machine, by constant running with little or no expense for repairs, may prove the cheapest in the long run, but these points can only be obtained by a careful study of the conditions and accurate expense accounts for long periods of time.

* * *

FOREIGN NOTES OF REAL INTEREST.

AT THE ANTWERP EXHIBITION.

A branch of engineering industry in which French manufacturers are making at least as much progress as those of other countries, is the production of special descriptions of bronze. In the attractively arranged stand of Messrs. Mathelin & Garnier, of Paris, some samples of bronze are shown, which seem to possess nearly all the qualifications required in good steel, with several others in which steel is wanting. This firm seem to have been experimenting in the same direction as Professor Roberts Austen, by examining the effect of the addition of minute quantities of manganese, aluminum, etc., to different descriptions of gun metal. More particularly they have been trying the effects of the introduction of phosphorus to an ordinary bronze in a state of fusion. For instance, they took two samples containing 88 parts of copper, 12 of tin and 2 of zinc, a proportion regularly used in French arsenals. One of these samples on being tested showed a breaking strain of 11 tons, and an extension of 5 to 7 per cent. The same metal phosphorized by their process had a breaking strain of 17 tons, and an extension of 14 per cent.

But their latest achievement, to which they have given the name of "Roma," from the Greek word, "strength," is much superior to the manganese bronze and phosphor bronze which they have shown at previous exhibitions. They do not give the exact constituents of this metal, but state that it contains copper, phosphorous, tin, aluminum, and manganese. Specimens of it are exhibited cast in various forms, rolled into bars and sheets, and drawn into boiler tubes or wires, as well as forgings which have been made from it. Roma is a pale yellow, has a specific gravity of 8.5, and melts at a temperature of about 1,000° C As it does not corrode in sea water, and is not magnetic, it is preferable to steel for the hulls of steamers, etc. A set of test bars are shown which have given the following results:

No. 1. Ordinary gun-metal, 10 to 13 tons per square inch breaking strain, 7 to 10 per cent. extension.

No. 2. Phospher bronze, 17 tons per square inch breaking strain, 8½ tons elastic limit, 15 per cent. extension.

No. 3. Roma, cast in sand, 22 tons per square inch breaking strain, 16½ tons elastic limit, 43 per cent. extension.

No. 4. Roma, cast in sand, 24½ tons per square inch breaking strain, 19½ tons elastic limit, 21½ per cent. extension.

No. 5. Roma, cast in a mould, 28 tons per square inch breaking strain, 20 tons elastic limit, 40 per cent. extension.

No. 6. Roma forged, 31 tons per square inch breaking strain, 22½ tons elastic limit, 35 per cent. extension.

No. 7. Roma rolled, 35 tons per square inch breaking strain, 26 tons elastic limit, 7½ per cent. extension.

The exhibitors state that with drawn tubes they have had 37 tons breaking strain, 24½ tons elastic limit, and 16 per cent extension; and with wire 62 tons breaking strain, 49 tons elastic limit, and 16 per cent. extension. Messrs. Mathelin & Garnier also exhibit a very pretty model of a torpedo boat, entirely constructed in Roma metal, and some photographs of screw propellers and other castings for naval construction. To one of these—the photograph of the screw for the Jaureguiberry, a casting weighing nine tons—is attached a copy of the official test made in May, 1893, showing a breaking strain of 24 tons, an elastic limit of 13 tons, and an extension of 21 per cent.

There is also shown a model of an interesting invention by M. P. Walraf, for taking up the *vis viva* of a tram-car when the brake is put on, and causing the wheels to revolve and to start the car directly the brake is removed. It consists principally of an intermediate shaft, on which a strong spiral spring is coiled. The shafts carrying the front and back wheels gear by means of intermediate pinions into a wheel on this shaft. Directly the brake is applied, it causes the spring on the intermediate shaft to tighten, and as long as the brake is on, it prevents the spring from uncoiling. Directly the pressure of the brake is removed, the spring causes the intermediate, and consequently the main wheels, to revolve, and thus starts the car. The extra weight of the apparatus is about 3 cwt.; but the inventor is endeavoring to simplify it, and thus make it lighter.—*The Engineer* (London).

METHODS OF DETERMINING THE DRYNESS OF STEAM.

The first business was the reading of Professor Unwin's report, as secretary of the committee appointed by the Association to investigate the question of the dryness of steam.

The committee consisted of Sir F. J. Bramwell, Bart., Professor T. A. Beare, Mr. Jeremiah Head, Professor A. B. Kennedy, Professor Osborne Reynolds, Mr. Mair Cumley, Mr. C. J. Wilson, and Professor Unwin (secretary). It was stated that Hirn was the first to appreciate the effects of the use of moist steam in engine and boiler trials, and pointed out that this moisture might arise from initial wetness, from condensation due to adiabatic expansion of the steam, or from the action of the cylinder walls. The initial wetness of the steam might arise from priming, and, as shown by Mr. Thornycroft, with certain waters, the whole steam space may be filled with bubbles, in which case very large quantities of water are entrained in the steam. With pure water this foaming does not occur. Variations of pressure may also cause priming, though probably not in any large quantities. Several methods have been proposed to determine the percentage of moisture present in steam. Messrs. Guzzi and Knight proposed to do this by weighing a definite quantity of the moist steam. A comparison of the weight thus found with the known density of dry steam, will permit the amount of water present in the sample to be determined. The method would be extremely difficult to use. Certain forms of separator collect the moisture in steam very thoroughly, a type designed by Professor Carpenter being particularly trustworthy, and is very simple in use, requiring no pressure gauges or thermometers. A sample of the steam to be tested is passed through the separator and thence to a condenser. Then, if W is the weight of water collected in the condenser, and w the weight of that collected in the separator, the dryness fraction is

$$x = \frac{W}{W + w}.$$

Hirn employed a condensing method in which samples of the steam to be tested were condensed, and the latent heat determined. A comparison of this with the heat due from an equal amount of dry steam according to Regnault's experiments, allows the dryness fraction to be determined. This method has also been adopted by Mr. Willans, but gives somewhat discrepant results. Messrs. Barrus, Hoadley, and others have used a continuous condensing method, in which steam drawn in a constant stream from the main steam pipe is condensed either in a jet or surface condenser. The theory is the same as in the last case, but the arrangements are more complicated. Mr. Barrus has also devised an apparatus in which a sample of the steam to be tested is superheated by being passed through a chamber surrounded by a jacket of superheated steam, but the device is only suitable for very dry steam. In another piece of apparatus Mr. Barrus effects the superheating by means of throttling the steam.

The apparatus is very accurate when the moisture is not too great, and as the only quantities to be observed are the thermometer readings, it is very simple to use. By the addition of a separator it can be used for steam containing very high percentages of moisture, but the quantity of steam passing through the

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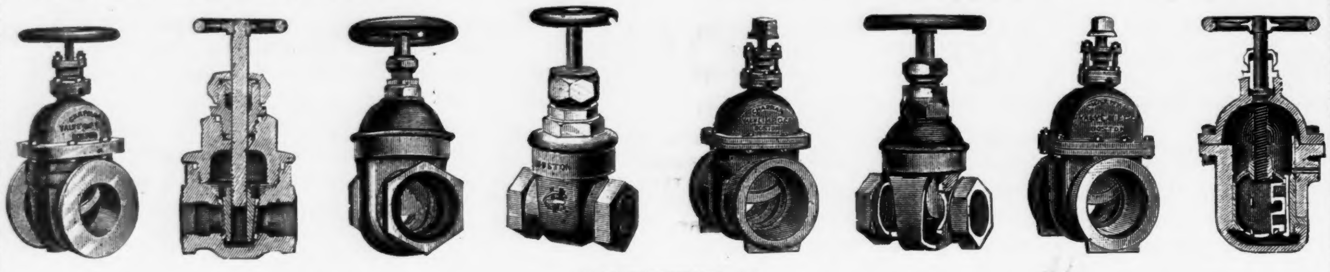

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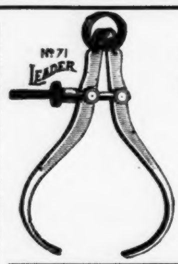

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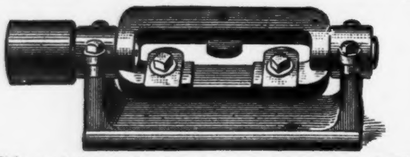

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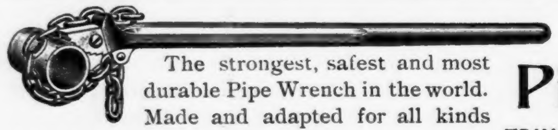

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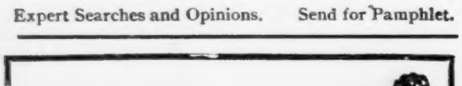

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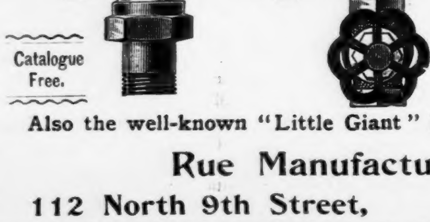

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instrument must then be weighed. It has frequently been proposed to determine the moisture of steam by measuring either the amount of salt found in the condensed steam, or the increase of saltness in a boiler at the end of a trial. Repeated experiments have, however, shown this method to be totally unreliable. —From meeting of the British Association. in *Engineering* (London.)

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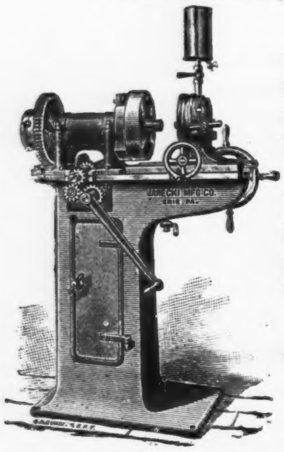

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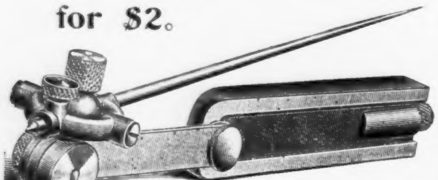

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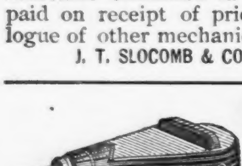

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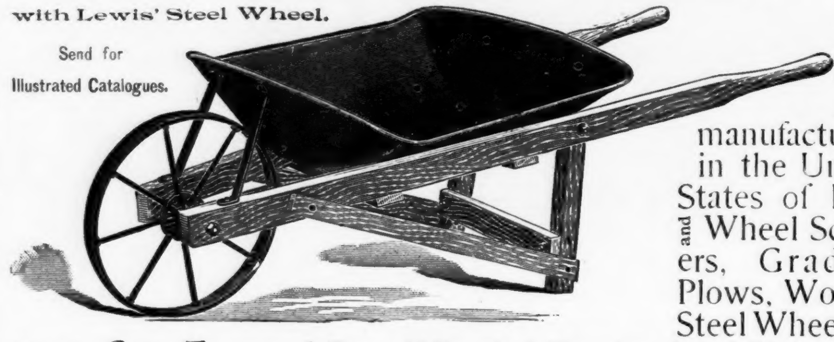

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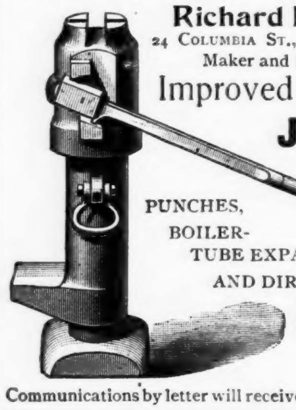

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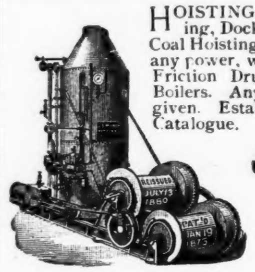

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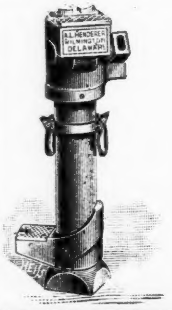

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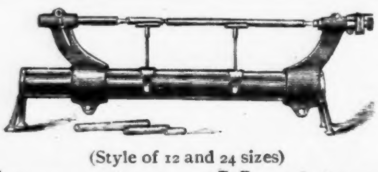

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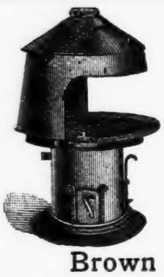

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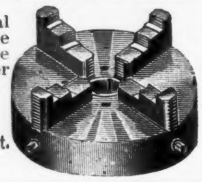

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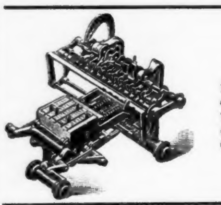

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